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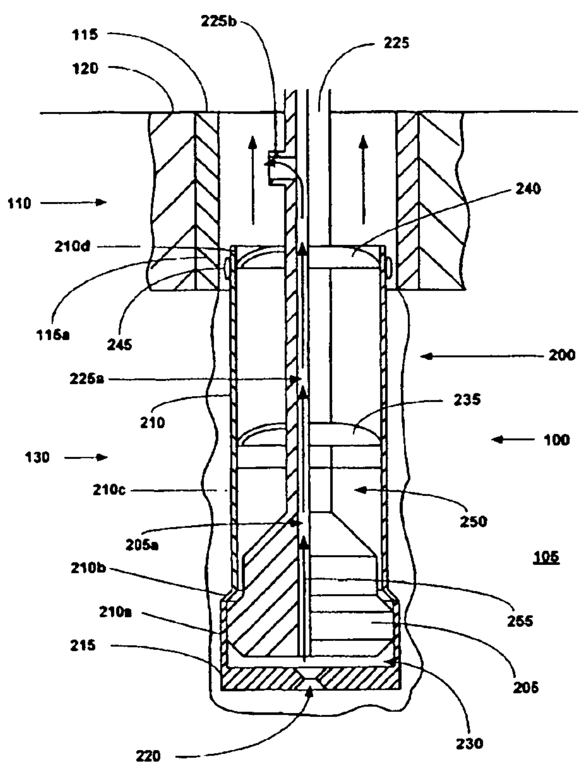
(54) Title: MONO-DIAMETER WELLBORE CASING



(57) Abstract: A mono-diameter casing formed when a tubular liner (210) and an expansion cone (205) are positioned within a new section fo a wellbore (100) and the tubular liner (210) is overlapped with a pre-existing casing (115). A hardening fluid is injected into the section of the wellbore (100) below the level of the expansion cone (205) and into the annular region between the tubular liner (210) and the wellbore (100). The inner and outer regions of the tubular liner (210) are isolated. Then a non-hardening fluid is injected into the interior region of the tubular liner (210) to pressurize it below the expansion cone (205). The overlapping portion of the pre-existing casing (115) and the tubular liner (210) are then expanded using an expansion cone (205).

WO 02/068792 A1

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MONO-DIAMETER WELLBORE CASING

Cross Reference To Related Applications

This application is a continuation-in-part of U.S. utility application serial number 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/111,293, attorney docket number 25791.3, filed on 12/7/1998, the disclosures of which are incorporated herein by reference.

This application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, and (22) U.S. provisional patent application

Background of the Invention

This invention relates generally to wellbore casings, and in particular to wellbore casings that are formed using expandable tubing.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming new sections of casing in a wellbore.

Summary of the Invention

According to one aspect of the present invention, a method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing is provided that includes installing a tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone.

According to another aspect of the present invention, an apparatus for forming a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing is provided that includes means for installing a tubular liner and a first expansion cone in the borehole, means for injecting a fluidic material into the borehole, means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone, means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone.

According to another aspect of the present invention, a method of joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member is provided that includes positioning a first expansion cone within an interior region of the second tubular member, pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone, extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member, and radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

According to another aspect of the present invention, an apparatus for joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member, is provided that includes means for positioning a first expansion cone within an interior region of the second tubular member, means for pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone, means for extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member, and means for radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

According to another aspect of the present invention, an apparatus is provided that includes a subterranean formation including a borehole, a wellbore casing coupled to the borehole, and a tubular liner coupled to the wellbore casing. The inside diameters of the wellbore casing and the tubular liner are substantially equal, and the tubular liner is coupled to the wellbore casing by a method that includes installing the

tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and radially expanding at least a portion of the wellbore casing and the tubular liner using a second expansion cone.

According to another aspect of the present invention, an apparatus is provided that includes a subterranean formation including a borehole, a first tubular member coupled to the borehole, and a second tubular member coupled to the wellbore casing. The inside diameters of the first and second tubular members are substantially equal, and the second tubular member is coupled to the first tubular member by a method that includes installing the second tubular member and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the second tubular member below the first expansion cone, radially expanding at least a portion of the second tubular member in the borehole by extruding at least a portion of the second tubular member off of the first expansion cone, and radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes a tubular support including first and second passages, a sealing member coupled to the tubular support, a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage, and an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

According to another aspect of the present invention, a method of radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes positioning an expansion cone within the wellbore casing above the overlapping joint, sealing off an annular region within the wellbore casing above the expansion cone, displacing the expansion cone by pressurizing the annular region, and removing fluidic materials displaced by the expansion cone from the tubular liner.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes means for positioning an expansion cone within the wellbore casing above the overlapping joint, means for sealing off an annular region within the

wellbore casing above the expansion cone, means for displacing the expansion cone by pressurizing the annular region, and means for removing fluidic materials displaced by the expansion cone from the tubular liner.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes a tubular support including a first passage, a sealing member coupled to the tubular support, a releasable latching member coupled to the tubular support, and an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

According to another aspect of the present invention, a method of radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes positioning an expansion cone within the wellbore casing above the overlapping joint, sealing off a region within the wellbore casing above the expansion cone, releasing the expansion cone, and displacing the expansion cone by pressurizing the annular region.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner is provided that includes means for positioning an expansion cone within the wellbore casing above the overlapping joint, means for sealing off a region within the wellbore casing above the expansion cone, means for releasing the expansion cone, and means for displacing the expansion cone by pressurizing the annular region.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between first and second tubular members is provided that includes a tubular support including first and second passages, a sealing member coupled to the tubular support, a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage, and an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

According to another aspect of the present invention, a method of radially expanding an overlapping joint between first and second tubular members is provided that includes positioning an expansion cone within the first tubular member above the overlapping joint, sealing off an annular region within the first tubular member above the expansion cone, displacing the expansion cone by pressurizing the annular region, and removing fluidic materials displaced by the expansion cone from the second tubular member.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between first and second tubular members is provided that includes means for positioning an expansion cone within the first tubular member above the overlapping joint, means for sealing off an annular region within the first tubular member above the expansion cone, means for displacing the expansion cone by pressurizing the annular region, and means for removing fluidic materials displaced by the expansion cone from the second tubular member.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between first and second tubular members is provided that includes a tubular support including a first passage, a sealing member coupled to the tubular support, a releasable latching member coupled to the tubular support, and an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

According to another aspect of the present invention, a method of radially expanding an overlapping joint between first and second tubular members is provided that includes positioning an expansion cone within the first tubular member above the overlapping joint, sealing off a region within the first tubular member above the expansion cone, releasing the expansion cone, and displacing the expansion cone by pressurizing the annular region.

According to another aspect of the present invention, an apparatus for radially expanding an overlapping joint between first and second tubular members is provided that includes means for positioning an expansion cone within the first tubular member above the overlapping joint, means for sealing off a region within the first tubular member above the expansion cone, means for releasing the expansion cone, and means for displacing the expansion cone by pressurizing the annular region.

Brief Description of the Drawings

FIG. 1 is a fragmentary cross-sectional view illustrating the drilling of a new section of a well borehole.

FIG. 2 is a fragmentary cross-sectional view illustrating the placement of an embodiment of an apparatus for creating a casing within the new section of the well borehole of FIG. 1.

FIG. 3 is a fragmentary cross-sectional view illustrating the injection of a hardenable fluidic sealing material into the new section of the well borehole of FIG. 2.

FIG. 4 is a fragmentary cross-sectional view illustrating the injection of a fluidic material into the new section of the well borehole of FIG. 3.

FIG. 5 is a fragmentary cross-sectional view illustrating the drilling out of the cured hardenable fluidic sealing material and the shoe from the new section of the well borehole of FIG. 4.

FIG. 6 is a cross-sectional view of the well borehole of FIG. 5 following the drilling out of the shoe.

FIG. 7 is a fragmentary cross-sectional view of the placement and actuation of an expansion cone within the well borehole of FIG. 6 for forming a mono-diameter wellbore casing.

FIG. 8 is a cross-sectional illustration of the well borehole of FIG. 7 following the formation of a mono-diameter wellbore casing.

FIG. 9 is a cross-sectional illustration of the well borehole of FIG. 8 following the repeated operation of the methods of FIGS. 1-8 in order to form a mono-diameter wellbore casing including a plurality of overlapping wellbore casings.

FIG. 10 is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of an apparatus for forming a mono-diameter wellbore casing into the well borehole of FIG. 6.

FIG. 11 is a cross-sectional illustration of the well borehole of FIG. 10 following the formation of a mono-diameter wellbore casing.

FIG. 12 is a fragmentary cross-sectional illustration of the placement of an alternative embodiment of an apparatus for forming a mono-diameter wellbore casing into the well borehole of FIG. 6.

FIG. 13 is a fragmentary cross-sectional illustration of the well borehole of FIG. 12 during the injection of pressurized fluids into the well borehole.

FIG. 14 is a fragmentary cross-sectional illustration of the well borehole of FIG. 13 during the formation of the mono-diameter wellbore casing.

FIG. 15 is a fragmentary cross-sectional illustration of the well borehole of FIG. 14 following the formation of the mono-diameter wellbore casing.

Detailed Description of the Illustrative Embodiments

Referring initially to FIGS. 1-9, an embodiment of an apparatus and method for forming a mono-diameter wellbore casing within a subterranean formation will now be described. As illustrated in Fig. 1, a wellbore 100 is positioned in a subterranean formation 105. The wellbore 100 includes a pre-existing cased section 110 having a tubular casing 115 and an annular outer layer 120 of a fluidic sealing material such as, for example, cement. The wellbore 100 may be positioned in any orientation from

vertical to horizontal. In several alternative embodiments, the pre-existing cased section 110 does not include the annular outer layer 120.

In order to extend the wellbore 100 into the subterranean formation 105, a drill string 125 is used in a well known manner to drill out material from the subterranean formation 105 to form a new wellbore section 130.

As illustrated in FIG. 2, an apparatus 200 for forming a wellbore casing in a subterranean formation is then positioned in the new section 130 of the wellbore 100. The apparatus 200 preferably includes an expansion cone 205 having a fluid passage 205a that supports a tubular member 210 that includes a lower portion 210a, an intermediate portion 210b, an upper portion 210c, and an upper end portion 210d.

The expansion cone 205 may be any number of conventional commercially available expansion cones. In several alternative embodiments, the expansion cone 205 may be controllably expandable in the radial direction, for example, as disclosed in U.S. patent nos. 5,348,095, and/or 6,012,523, the disclosures of which are incorporated herein by reference.

The tubular member 210 may be fabricated from any number of conventional commercially available materials such as, for example, Oilfield Country Tubular Goods (OCTG), 13 chromium steel tubing/casing, or plastic tubing/casing. In a preferred embodiment, the tubular member 210 is fabricated from OCTG in order to maximize strength after expansion. In several alternative embodiments, the tubular member 210 may be solid and/or slotted. In a preferred embodiment, the length of the tubular member 210 is limited to minimize the possibility of buckling. For typical tubular member 210 materials, the length of the tubular member 210 is preferably limited to between about 40 to 20,000 feet in length.

The lower portion 210a of the tubular member 210 preferably has a larger inside diameter than the upper portion 210c of the tubular member. In a preferred embodiment, the wall thickness of the intermediate portion 210b of the tubular member 201 is less than the wall thickness of the upper portion 210c of the tubular member in order to faciliate the initiation of the radial expansion process. In a preferred embodiment, the upper end portion 210d of the tubular member 210 is slotted, perforated, or otherwise modified to catch or slow down the expansion cone 205 when it completes the extrusion of tubular member 210.

A shoe 215 is coupled to the lower portion 210a of the tubular member. The shoe 215 includes a valveable fluid passage 220 that is preferably adapted to receive a plug, dart, or other similar element for controllably sealing the fluid passage 220. In

this manner, the fluid passage 220 may be optimally sealed off by introducing a plug, dart and/or ball sealing elements into the fluid passage 240.

The shoe 215 may be any number of conventional commercially available shoes such as, for example, Super Seal II float shoe, Super Seal II Down-Jet float shoe or a guide shoe with a sealing sleeve for a latch down plug modified in accordance with the teachings of the present disclosure. In a preferred embodiment, the shoe 215 is an aluminum down-jet guide shoe with a sealing sleeve for a latch-down plug available from Halliburton Energy Services in Dallas, TX, modified in accordance with the teachings of the present disclosure, in order to optimally guide the tubular member 210 in the wellbore, optimally provide an adequate seal between the interior and exterior diameters of the overlapping joint between the tubular members, and to optimally allow the complete drill out of the shoe and plug after the completion of the cementing and expansion operations.

In a preferred embodiment, the shoe 215 further includes one or more through and side outlet ports in fluidic communication with the fluid passage 220. In this manner, the shoe 215 optimally injects hardenable fluidic sealing material into the region outside the shoe 215 and tubular member 210.

A support member 225 having fluid passages 225a and 225b is coupled to the expansion cone 205 for supporting the apparatus 200. The fluid passage 225a is preferably fluidicly coupled to the fluid passage 205a. In this manner, fluidic materials may be conveyed to and from a region 230 below the expansion cone 205 and above the bottom of the shoe 215. The fluid passage 225b is preferably fluidicly coupled to the fluid passage 225a and includes a conventional control valve. In this manner, during placement of the apparatus 200 within the wellbore 100, surge pressures can be relieved by the fluid passage 225b. In a preferred embodiment, the support member 225 further includes one or more conventional centralizers (not illustrated) to help stabilize the apparatus 200.

During placement of the apparatus 200 within the wellbore 100, the fluid passage 225a is preferably selected to transport materials such as, for example, drilling mud or formation fluids at flow rates and pressures ranging from about 0 to 3,000 gallons/minute and 0 to 9,000 psi in order to minimize drag on the tubular member being run and to minimize surge pressures exerted on the wellbore 130 which could cause a loss of wellbore fluids and lead to hole collapse. During placement of the apparatus 200 within the wellbore 100, the fluid passage 225b is preferably selected to convey fluidic materials at flow rates and pressures ranging from about 0 to 3,000

gallons/minute and 0 to 9,000 psi in order to reduce the drag on the apparatus 200 during insertion into the new section 130 of the wellbore 100 and to minimize surge pressures on the new wellbore section 130.

A lower cup seal 235 is coupled to and supported by the support member 225. The lower cup seal 235 prevents foreign materials from entering the interior region of the tubular member 210 adjacent to the expansion cone 205. The lower cup seal 235 may be any number of conventional commercially available cup seals such as, for example, TP cups, or Selective Injection Packer (SIP) cups modified in accordance with the teachings of the present disclosure. In a preferred embodiment, the lower cup seal 235 is a SIP cup seal, available from Halliburton Energy Services in Dallas, TX in order to optimally block foreign material and contain a body of lubricant.

The upper cup seal 240 is coupled to and supported by the support member 225. The upper cup seal 240 prevents foreign materials from entering the interior region of the tubular member 210. The upper cup seal 240 may be any number of conventional commercially available cup seals such as, for example, TP cups or SIP cups modified in accordance with the teachings of the present disclosure. In a preferred embodiment, the upper cup seal 240 is a SIP cup, available from Halliburton Energy Services in Dallas, TX in order to optimally block the entry of foreign materials and contain a body of lubricant.

One or more sealing members 245 are coupled to and supported by the exterior surface of the upper end portion 210d of the tubular member 210. The seal members 245 preferably provide an overlapping joint between the lower end portion 115a of the casing 115 and the portion 260 of the tubular member 210 to be fluidicly sealed. The sealing members 245 may be any number of conventional commercially available seals such as, for example, lead, rubber, Teflon, or epoxy seals modified in accordance with the teachings of the present disclosure. In a preferred embodiment, the sealing members 245 are molded from Stratalock epoxy available from Halliburton Energy Services in Dallas, TX in order to optimally provide a load bearing interference fit between the upper end portion 210d of the tubular member 210 and the lower end portion 115a of the existing casing 115.

In a preferred embodiment, the sealing members 245 are selected to optimally provide a sufficient frictional force to support the expanded tubular member 210 from the existing casing 115. In a preferred embodiment, the frictional force optimally provided by the sealing members 245 ranges from about 1,000 to 1,000,000 lbf in order to optimally support the expanded tubular member 210.

In a preferred embodiment, a quantity of lubricant 250 is provided in the annular region above the expansion cone 205 within the interior of the tubular member 210. In this manner, the extrusion of the tubular member 210 off of the expansion cone 205 is facilitated. The lubricant 250 may be any number of conventional commercially available lubricants such as, for example, Lubriplate, chlorine based lubricants, oil based lubricants or Climax 1500 Antisieze (3100). In a preferred embodiment, the lubricant 250 is Climax 1500 Antisieze (3100) available from Climax Lubricants and Equipment Co. in Houston, TX in order to optimally provide optimum lubrication to faciliate the expansion process.

In a preferred embodiment, the support member 225 is thoroughly cleaned prior to assembly to the remaining portions of the apparatus 200. In this manner, the introduction of foreign material into the apparatus 200 is minimized. This minimizes the possibility of foreign material clogging the various flow passages and valves of the apparatus 200.

In a preferred embodiment, before or after positioning the apparatus 200 within the new section 130 of the wellbore 100, a couple of wellbore volumes are circulated in order to ensure that no foreign materials are located within the wellbore 100 that might clog up the various flow passages and valves of the apparatus 200 and to ensure that no foreign material interferes with the expansion process.

As illustrated in FIG. 2, in a preferred embodiment, during placement of the apparatus 200 within the wellbore 100, fluidic materials 255 within the wellbore that are displaced by the apparatus are conveyed through the fluid passages 220, 205a, 225a, and 225b. In this manner, surge pressures created by the placement of the apparatus within the wellbore 100 are reduced.

As illustrated in FIG. 3, the fluid passage 225b is then closed and a hardenable fluidic sealing material 305 is then pumped from a surface location into the fluid passages 225a and 205a. The material 305 then passes from the fluid passage 205a into the interior region 230 of the tubular member 210 below the expansion cone 205. The material 305 then passes from the interior region 230 into the fluid passage 220. The material 305 then exits the apparatus 200 and fills an annular region 310 between the exterior of the tubular member 210 and the interior wall of the new section 130 of the wellbore 100. Continued pumping of the material 305 causes the material 305 to fill up at least a portion of the annular region 310.

The material 305 is preferably pumped into the annular region 310 at pressures and flow rates ranging, for example, from about 0 to 5000 psi and 0 to 1,500

gallons/min, respectively. The optimum flow rate and operating pressures vary as a function of the casing and wellbore sizes, wellbore section length, available pumping equipment, and fluid properties of the fluidic material being pumped. The optimum flow rate and operating pressure are preferably determined using conventional empirical methods.

The hardenable fluidic sealing material 305 may be any number of conventional commercially available hardenable fluidic sealing materials such as, for example, slag mix, cement or epoxy. In a preferred embodiment, the hardenable fluidic sealing material 305 is a blended cement prepared specifically for the particular well section being drilled from Halliburton Energy Services in Dallas, TX in order to provide optimal support for tubular member 210 while also maintaining optimum flow characteristics so as to minimize difficulties during the displacement of cement in the annular region 315. The optimum blend of the blended cement is preferably determined using conventional empirical methods. In several alternative embodiments, the hardenable fluidic sealing material 305 is compressible before, during, or after curing.

The annular region 310 preferably is filled with the material 305 in sufficient quantities to ensure that, upon radial expansion of the tubular member 210, the annular region 310 of the new section 130 of the wellbore 100 will be filled with the material 305.

In an alternative embodiment, the injection of the material 305 into the annular region 310 is omitted.

As illustrated in FIG. 4, once the annular region 310 has been adequately filled with the material 305, a plug 405, or other similar device, is introduced into the fluid passage 220, thereby fluidicly isolating the interior region 230 from the annular region 310. In a preferred embodiment, a non-hardenable fluidic material 315 is then pumped into the interior region 230 causing the interior region to pressurize. In this manner, the interior region 230 of the expanded tubular member 210 will not contain significant amounts of cured material 305. This also reduces and simplifies the cost of the entire process. Alternatively, the material 305 may be used during this phase of the process.

Once the interior region 230 becomes sufficiently pressurized, the tubular member 210 is preferably plastically deformed, radially expanded, and extruded off of the expansion cone 205. During the extrusion process, the expansion cone 205 may be raised out of the expanded portion of the tubular member 210. In a preferred

embodiment, during the extrusion process, the expansion cone 205 is raised at approximately the same rate as the tubular member 210 is expanded in order to keep the tubular member 210 stationary relative to the new wellbore section 130. In an alternative preferred embodiment, the extrusion process is commenced with the tubular member 210 positioned above the bottom of the new wellbore section 130, keeping the expansion cone 205 stationary, and allowing the tubular member 210 to extrude off of the expansion cone 205 and into the new wellbore section 130 under the force of gravity and the operating pressure of the interior region 230.

The plug 405 is preferably placed into the fluid passage 220 by introducing the plug 405 into the fluid passage 225a at a surface location in a conventional manner. The plug 405 preferably acts to fluidicly isolate the hardenable fluidic sealing material 305 from the non hardenable fluidic material 315.

The plug 405 may be any number of conventional commercially available devices from plugging a fluid passage such as, for example, Multiple Stage Cementer (MSC) latch-down plug, Omega latch-down plug or three-wiper latch-down plug modified in accordance with the teachings of the present disclosure. In a preferred embodiment, the plug 405 is a MSC latch-down plug available from Halliburton Energy Services in Dallas, TX.

After placement of the plug 405 in the fluid passage 220, the non hardenable fluidic material 315 is preferably pumped into the interior region 310 at pressures and flow rates ranging, for example, from approximately 400 to 10,000 psi and 30 to 4,000 gallons/min. In this manner, the amount of hardenable fluidic sealing material within the interior 230 of the tubular member 210 is minimized. In a preferred embodiment, after placement of the plug 405 in the fluid passage 220, the non hardenable material 315 is preferably pumped into the interior region 230 at pressures and flow rates ranging from approximately 500 to 9,000 psi and 40 to 3,000 gallons/min in order to maximize the extrusion speed.

In a preferred embodiment, the apparatus 200 is adapted to minimize tensile, burst, and friction effects upon the tubular member 210 during the expansion process. These effects will be depend upon the geometry of the expansion cone 205, the material composition of the tubular member 210 and expansion cone 205, the inner diameter of the tubular member 210, the wall thickness of the tubular member 210, the type of lubricant, and the yield strength of the tubular member 210. In general, the thicker the wall thickness, the smaller the inner diameter, and the greater the

yield strength of the tubular member 210, then the greater the operating pressures required to extrude the tubular member 210 off of the expansion cone 205.

For typical tubular members 210, the extrusion of the tubular member 210 off of the expansion cone 205 will begin when the pressure of the interior region 230 reaches, for example, approximately 500 to 9,000 psi.

During the extrusion process, the expansion cone 205 may be raised out of the expanded portion of the tubular member 210 at rates ranging, for example, from about 0 to 5 ft/sec. In a preferred embodiment, during the extrusion process, the expansion cone 205 is raised out of the expanded portion of the tubular member 210 at rates ranging from about 0 to 2 ft/sec in order to minimize the time required for the expansion process while also permitting easy control of the expansion process.

When the upper end portion 210d of the tubular member 210 is extruded off of the expansion cone 205, the outer surface of the upper end portion 210d of the tubular member 210 will preferably contact the interior surface of the lower end portion 115a of the casing 115 to form an fluid tight overlapping joint. The contact pressure of the overlapping joint may range, for example, from approximately 50 to 20,000 psi. In a preferred embodiment, the contact pressure of the overlapping joint ranges from approximately 400 to 10,000 psi in order to provide optimum pressure to activate the annular sealing members 245 and optimally provide resistance to axial motion to accommodate typical tensile and compressive loads.

The overlapping joint between the existing casing 115 and the radially expanded tubular member 210 preferably provides a gaseous and fluidic seal. In a particularly preferred embodiment, the sealing members 245 optimally provide a fluidic and gaseous seal in the overlapping joint. In an alternative embodiment, the sealing members 245 are omitted.

In a preferred embodiment, the operating pressure and flow rate of the non-hardenable fluidic material 315 is controllably ramped down when the expansion cone 205 reaches the upper end portion 210d of the tubular member 210. In this manner, the sudden release of pressure caused by the complete extrusion of the tubular member 210 off of the expansion cone 205 can be minimized. In a preferred embodiment, the operating pressure is reduced in a substantially linear fashion from 100% to about 10% during the end of the extrusion process beginning when the expansion cone 205 is within about 5 feet from completion of the extrusion process.

Alternatively, or in combination, a shock absorber is provided in the support member 225 in order to absorb the shock caused by the sudden release of pressure.

The shock absorber may, for example, be any conventional commercially available shock absorber adapted for use in wellbore operations.

Alternatively, or in combination, an expansion cone catching structure is provided in the upper end portion 210d of the tubular member 210 in order to catch or at least decelerate the expansion cone 205.

Once the extrusion process is completed, the expansion cone 205 is removed from the wellbore 100. In a preferred embodiment, either before or after the removal of the expansion cone 205, the integrity of the fluidic seal of the overlapping joint between the upper end portion 210d of the tubular member 210 and the lower end portion 115a of the preexisting wellbore casing 115 is tested using conventional methods.

In a preferred embodiment, if the fluidic seal of the overlapping joint between the upper end portion 210d of the tubular member 210 and the lower end portion 115a of the casing 115 is satisfactory, then any uncured portion of the material 305 within the expanded tubular member 210 is then removed in a conventional manner such as, for example, circulating the uncured material out of the interior of the expanded tubular member 210. The expansion cone 205 is then pulled out of the wellbore section 130 and a drill bit or mill is used in combination with a conventional drilling assembly 505 to drill out any hardened material 305 within the tubular member 210. In a preferred embodiment, the material 305 within the annular region 310 is then allowed to fully cure.

As illustrated in Fig. 5, preferably any remaining cured material 305 within the interior of the expanded tubular member 210 is then removed in a conventional manner using a conventional drill string 505. The resulting new section of casing 510 preferably includes the expanded tubular member 210 and an outer annular layer 515 of the cured material 305.

As illustrated in FIG. 6, the bottom portion of the apparatus 200 including the shoe 215 and dart 405 may then be removed by drilling out the shoe 215 and dart 405 using conventional drilling methods.

As illustrated in FIG. 7, an apparatus 600 for forming a mono-diameter wellbore casing is then positioned within the wellbore casing 115 proximate the tubular member 210 that includes an expansion cone 605 and a support member 610. In a preferred embodiment, the outside diameter of the expansion cone 605 is substantially equal to the inside diameter of the wellbore casing 115. The apparatus 600 preferably further includes a fluid passage 615 for conveying fluidic materials 620

out of the wellbore 100 that are displaced by the placement and operation of the expansion cone 605.

The expansion cone 605 is then driven downward using the support member 610 in order to radially expand and plastically deform the tubular member 210 and the overlapping portion of the tubular member 115. In this manner, as illustrated in FIG. 8, a mono-diameter wellbore casing is formed that includes the overlapping wellbore casings 115 and 210. In several alternative embodiments, the secondary radial expansion process is performed before, during, or after the material 515 fully cures. In several alternative embodiments, a conventional expansion device including rollers may be substituted for, or used in combination with, the apparatus 600.

More generally, as illustrated in FIG. 9, the method of FIGS. 1-8 is repeatedly performed in order to provide a mono-diameter wellbore casing that includes overlapping wellbore casings 115 and 210a-210e. The wellbore casing 115, and 210a-210e preferably include outer annular layers of fluidic sealing material. In this manner, a mono-diameter wellbore casing may be formed within the subterranean formation that extends for tens of thousands of feet. More generally still, the teachings of FIGS. 1-9 may be used to form a mono-diameter wellbore casing, a pipeline, a structural support, or a tunnel within a subterranean formation at any orientation from the vertical to the horizontal.

In a preferred embodiment, the formation of a mono-diameter wellbore casing, as illustrated in FIGS. 1-9, is further provided as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional

patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, and (22) U.S. provisional patent application serial no. ____________, attorney docket no. 25791.52, filed on 1/3/2001, the disclosures of which are incorporated herein by reference.

In an alternative embodiment, the fluid passage 220 in the shoe 215 is omitted. In this manner, the pressurization of the region 230 is simplified. In an alternative embodiment, the annular body 515 of the fluidic sealing material is formed using conventional methods of injecting a hardenable fluidic sealing material into the annular region 310.

Referring to FIGS. 10-11, in an alternative embodiment, an apparatus 700 for forming a mono-diameter wellbore casing is positioned within the wellbore casing 115 that includes an expansion cone 705 having a fluid passage 705a that is coupled to a support member 710.

The expansion cone 705 preferably further includes a conical outer surface 705b for radially expanding and plastically deforming the overlapping portion of the tubular member 115 and the tubular member 210. In a preferred embodiment, the outside diameter of the expansion cone 705 is substantially equal to the inside diameter of the pre-existing wellbore casing 115.

The support member 710 is coupled to a slip joint 715, and the slip joint is coupled to a support member 720. As will be recognized by persons having ordinary skill in the art, a slip joint permits relative movement between objects. Thus, in this manner, the expansion cone 705 and support member 710 may be displaced in the longitudinal direction relative to the support member 720. In a preferred

embodiment, the slip joint 710 permits the expansion cone 705 and support member 710 to be displaced in the longitudinal direction relative to the support member 720 for a distance greater than or equal to the axial length of the tubular member 210. In this manner, the expansion cone 705 may be used to plastically deform and radially expand the overlapping portion of the tubular member 115 and the tubular member 210 without having to reposition the support member 720.

The slip joint 715 may be any number of conventional commercially available slip joints that include a fluid passage for conveying fluidic materials through the slip joint. In a preferred embodiment, the slip joint 715 is a pumper sub commercially available from Bowen Oil Tools in order to optimally provide elongation of the drill string.

The support member 710, slip joint 715, and support member 720 further include fluid passages 710a, 715a, and 720a, respectively, that are fluidicly coupled to the fluid passage 705a. During operation, the fluid passages 705a, 710a, 715a, and 720a preferably permit fluidic materials 725 displaced by the expansion cone 705 to be conveyed to a location above the apparatus 700. In this manner, operating pressures within the subterranean formation 105 below the expansion cone are minimized.

The support member 720 further preferably includes a fluid passage 720b that permits fluidic materials 730 to be conveyed into an annular region 735 surrounding the support member 710, the slip joint 715, and the support member 720 and bounded by the expansion cone 705 and a conventional packer 740 that is coupled to the support member 720. In this manner, the annular region 735 may be pressurized by the injection of the fluids 730 thereby causing the expansion cone 705 to be displaced in the longitudinal direction relative to the support member 720 to thereby plastically deform and radially expand the overlapping portion of the tubular member 115 and the tubular member 210.

During operation, as illustrated in FIG. 10, in a preferred embodiment, the apparatus 700 is positioned within the preexisting casing 115 with the bottom surface of the expansion cone 705 proximate the top of the tubular member 210. During placement of the apparatus 700 within the preexisting casing 115, fluidic materials 725 within the casing are conveyed out of the casing through the fluid passages 705a, 710a, 715a, and 720a. In this manner, surge pressures within the wellbore 100 are minimized.

The packer 740 is then operated in a well-known manner to fluidicly isolate the annular region 735 from the annular region above the packer. The fluidic material

730 is then injected into the annular region 735 using the fluid passage 720b. Continued injection of the fluidic material 730 into the annular region 735 preferably pressurizes the annular region and thereby causes the expansion cone 705 and support member 710 to be displaced in the longitudinal direction relative to the support member 720.

As illustrated in FIG. 11, in a preferred embodiment, the longitudinal displacement of the expansion cone 705 in turn plastically deforms and radially expands the overlapping portion of the tubular member 115 and the tubular member 210. In this manner, a mono-diameter wellbore casing is formed that includes the overlapping wellbore casings 115 and 210. The apparatus 700 may then be removed from the wellbore 100 by releasing the packer 740 from engagement with the wellbore casing 115, and lifting the apparatus 700 out of the wellbore 100.

In an alternative embodiment of the apparatus 700, the fluid passage 720b is provided within the packer 740 in order to enhance the operation of the apparatus 700.

In an alternative embodiment of the apparatus 700, the fluid passages 705a, 710a, 715a, and 720a are omitted. In this manner, in a preferred embodiment, the region of the wellbore 100 below the expansion cone 705 is pressurized and one or more regions of the subterranean formation 105 are fractured to enhance the oil and/or gas recovery process.

Referring to FIGS. 12-15, in an alternative embodiment, an apparatus 800 is positioned within the wellbore casing 115 that includes an expansion cone 805 having a fluid passage 805a that is releasably coupled to a releasable coupling 810 having fluid passage 810a.

The fluid passage 805a is preferably adapted to receive a conventional ball, plug, or other similar device for sealing off the fluid passage. The expansion cone 805 further includes a conical outer surface 805b for radially expanding and plastically deforming the overlapping portion of the tubular member 115 and the tubular member 210. In a preferred embodiment, the outside diameter of the expansion cone 805 is substantially equal to the inside diameter of the pre-existing wellbore casing 115.

The releasable coupling 810 may be any number of conventional commercially available releasable couplings that include a fluid passage for conveying fluidic materials through the releasable coupling. In a preferred embodiment, the releasable coupling 810 is a safety joint commercially available from Halliburton in order to

optimally release the expansion cone 805 from the support member 815 at a predetermined location.

A support member 815 is coupled to the releasable coupling 810 that includes a fluid passage 815a. The fluid passages 805a, 810a and 815a are fluidicly coupled. In this manner, fluidic materials may be conveyed into and out of the wellbore 100.

A packer 820 is movably and sealingly coupled to the support member 815. The packer may be any number of conventional packers. In a preferred embodiment, the packer 820 is a commercially available burst preventer (BOP) in order to optimally provide a sealing member.

During operation, as illustrated in FIG. 12, in a preferred embodiment, the apparatus 800 is positioned within the preexisting casing 115 with the bottom surface of the expansion cone 805 proximate the top of the tubular member 210. During placement of the apparatus 800 within the preexisting casing 115, fluidic materials 825 within the casing are conveyed out of the casing through the fluid passages 805a, 810a, and 815a. In this manner, surge pressures within the wellbore 100 are minimized. The packer 820 is then operated in a well-known manner to fluidicly isolate a region 830 within the casing 115 between the expansion cone 805 and the packer 820 from the region above the packer.

In a preferred embodiment, as illustrated in FIG. 13, the releasable coupling 810 is then released from engagement with the expansion cone 805 and the support member 815 is moved away from the expansion cone. A fluidic material 835 may then be injected into the region 830 through the fluid passages 810a and 815a. The fluidic material 835 may then flow into the region of the wellbore 100 below the expansion cone 805 through the valveable passage 805b. Continued injection of the fluidic material 835 may thereby pressurize and fracture regions of the formation 105 below the tubular member 210. In this manner, the recovery of oil and/or gas from the formation 105 may be enhanced.

In a preferred embodiment, as illustrated in FIG. 14, a plug, ball, or other similar valve device 840 may then be positioned in the valveable passage 805a by introducing the valve device into the fluidic material 835. In this manner, the region 830 may be fluidicly isolated from the region below the expansion cone 805. Continued injection of the fluidic material 835 may then pressurize the region 830 thereby causing the expansion cone 805 to be displaced in the longitudinal direction.

In a preferred embodiment, as illustrated in FIG. 15, the longitudinal displacement of the expansion cone 805 plastically deforms and radially expands the

overlapping portion of the pre-existing wellbore casing 115 and the tubular member 210. In this manner, a mono-diameter wellbore casing is formed that includes the pre-existing wellbore casing 115 and the tubular member 210. Upon completing the radial expansion process, the support member 815 may be moved toward the expansion cone 805 and the expansion cone may be re-coupled to the releasable coupling device 810. The packer 820 may then be decoupled from the wellbore casing 115, and the expansion cone 805 and the remainder of the apparatus 800 may then be removed from the wellbore 100.

In a preferred embodiment, the displacement of the expansion cone 805 also pressurizes the region within the tubular member 210 below the expansion cone. In this manner, the subterranean formation surrounding the tubular member 210 may be elastically or plastically compressed thereby enhancing the structural properties of the formation.

A method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing has been described that includes installing a tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone. In a preferred embodiment, radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

An apparatus for forming a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing has also been described that includes means for installing a tubular liner and a first expansion cone in the borehole, means for injecting a fluidic material into the borehole, means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone, means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone. In a preferred embodiment, the means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In a preferred embodiment, the means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In a preferred embodiment, the apparatus further includes means for injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

A method of joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member has also been described that includes positioning a first expansion cone within an interior region of the second tubular member, pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone, extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member, and radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone. In a preferred embodiment, radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone includes

displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, radially expanding at least a portion of the first and second tubular members using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, the method further includes injecting a hardenable fluidic sealing material into an annulus around the second tubular member.

An apparatus for joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member, has also been described that includes means for positioning a first expansion cone within an interior region of the second tubular member, means for pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone, means for extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member, and means for radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone. In a preferred embodiment, the means for radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In a preferred embodiment, the means for radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone includes means for displacing the second expansion cone in a longitudinal direction, and means for compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, the means for displacing the second expansion cone in a longitudinal direction includes means for applying fluid pressure to the second expansion cone. In a preferred embodiment, the apparatus further

includes means for injecting a hardenable fluidic sealing material into an annulus around the second tubular member.

An apparatus has also been described that includes a subterranean formation including a borehole, a wellbore casing coupled to the borehole, and a tubular liner coupled to the wellbore casing. The inside diameters of the wellbore casing and the tubular liner are substantially equal, and the tubular liner is coupled to the wellbore casing by a method that includes installing the tubular liner and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the tubular liner below the first expansion cone, radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone, and radially expanding at least a portion of the wellbore casing and the tubular liner using a second expansion cone. In a preferred embodiment, radially expanding at least a portion of the wellbore casing and the tubular liner using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, radially expanding at least a portion of the wellbore casing and the tubular liner using the second expansion cone includes displacing the second expansion cone in a longitudinal direction and compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, the annular layer of the fluidic sealing material is formed by a method that includes injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

An apparatus has also been described that includes a subterranean formation including a borehole, a first tubular member coupled to the borehole, and a second tubular member coupled to the wellbore casing. The inside diameters of the first and second tubular members are substantially equal, and the second tubular member is coupled to the first tubular member by a method that includes installing the second tubular member and a first expansion cone in the borehole, injecting a fluidic material into the borehole, pressurizing a portion of an interior region of the second tubular member below the first expansion cone, radially expanding at least a portion of the second tubular member in the borehole by extruding at least a portion of the second

tubular member off of the first expansion cone, and radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone. In a preferred embodiment, radially expanding at least a portion of the first and second tubular members using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and permitting fluidic materials displaced by the second expansion cone to be removed. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, radially expanding at least a portion of the first and second tubular members using the second expansion cone includes displacing the second expansion cone in a longitudinal direction, and compressing at least a portion of the subterranean formation using fluid pressure. In a preferred embodiment, displacing the second expansion cone in a longitudinal direction includes applying fluid pressure to the second expansion cone. In a preferred embodiment, the annular layer of the fluidic sealing material is formed by a method that includes injecting a hardenable fluidic sealing material into an annulus between the first tubular member and the borehole.

An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes a tubular support including first and second passages, a sealing member coupled to the tubular support, a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage, and an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

A method of radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes positioning an expansion cone within the wellbore casing above the overlapping joint, sealing off an annular region within the wellbore casing above the expansion cone, displacing the expansion cone by pressurizing the annular region, and removing fluidic materials displaced by the expansion cone from the tubular liner. In a preferred embodiment, the method further includes supporting the expansion cone during the displacement of the expansion cone.

An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes means for positioning an expansion cone within the wellbore casing above the overlapping joint, means for sealing off an annular region within the wellbore casing above the expansion cone, means for displacing the expansion cone by pressurizing the annular region, and

means for removing fluidic materials displaced by the expansion cone from the tubular liner. In a preferred embodiment, the apparatus further includes means for supporting the expansion cone during the displacement of the expansion cone.

An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes a tubular support including a first passage, a sealing member coupled to the tubular support, a releasable latching member coupled to the tubular support, and an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

A method of radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes positioning an expansion cone within the wellbore casing above the overlapping joint, sealing off a region within the wellbore casing above the expansion cone, releasing the expansion cone, and displacing the expansion cone by pressurizing the annular region. In a preferred embodiment, the method further includes pressurizing the interior of the tubular liner.

An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner has also been described that includes means for positioning an expansion cone within the wellbore casing above the overlapping joint, means for sealing off a region within the wellbore casing above the expansion cone, means for releasing the expansion cone, and means for displacing the expansion cone by pressurizing the annular region. In a preferred embodiment, the apparatus further includes means for pressurizing the interior of the tubular liner.

An apparatus for radially expanding an overlapping joint between first and second tubular members has also been described that includes a tubular support including first and second passages, a sealing member coupled to the tubular support, a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage, and an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

A method of radially expanding an overlapping joint between first and second tubular members has also been described that includes positioning an expansion cone within the first tubular member above the overlapping joint, sealing off an annular region within the first tubular member above the expansion cone, displacing the expansion cone by pressurizing the annular region, and removing fluidic materials displaced by the expansion cone from the second tubular member. In a preferred

embodiment, the method further includes supporting the expansion cone during the displacement of the expansion cone.

An apparatus for radially expanding an overlapping joint between first and second tubular members has also been described that includes means for positioning an expansion cone within the first tubular member above the overlapping joint, means for sealing off an annular region within the first tubular member above the expansion cone, means for displacing the expansion cone by pressurizing the annular region, and means for removing fluidic materials displaced by the expansion cone from the second tubular member. In a preferred embodiment, the apparatus further includes means for supporting the expansion cone during the displacement of the expansion cone.

An apparatus for radially expanding an overlapping joint between first and second tubular members has also been described that includes a tubular support including a first passage, a sealing member coupled to the tubular support, a releasable latching member coupled to the tubular support, and an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

A method of radially expanding an overlapping joint between first and second tubular members has also been described that includes positioning an expansion cone within the first tubular member above the overlapping joint, sealing off a region within the first tubular member above the expansion cone, releasing the expansion cone, and displacing the expansion cone by pressurizing the annular region. In a preferred embodiment, the method further includes pressurizing the interior of the second tubular member.

An apparatus for radially expanding an overlapping joint between first and second tubular members has also been described that includes means for positioning an expansion cone within the first tubular member above the overlapping joint, means for sealing off a region within the first tubular member above the expansion cone, means for releasing the expansion cone, and means for displacing the expansion cone by pressurizing the annular region. In a preferred embodiment, the apparatus further includes means for pressurizing the interior of the second tubular member.

Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is

appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

What is claimed is:

1. A method of creating a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing, comprising:
installing a tubular liner and a first expansion cone in the borehole;
injecting a fluidic material into the borehole;
pressurizing a portion of an interior region of the tubular liner below the first expansion cone;
radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone; and
radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone.

2. The method of claim 1, wherein radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone comprises:
displacing the second expansion cone in a longitudinal direction; and
permitting fluidic materials displaced by the second expansion cone to be removed.

3. The method of claim 2, wherein displacing the second expansion cone in a longitudinal direction comprises:
applying fluid pressure to the second expansion cone.

4. The method of claim 1, wherein radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone comprises:
displacing the second expansion cone in a longitudinal direction; and
compressing at least a portion of the subterranean formation using fluid pressure.

5. The method of claim 4, wherein displacing the second expansion cone in a longitudinal direction comprises:
applying fluid pressure to the second expansion cone.

6. The method of claim 1, further comprising:

injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

7. An apparatus for forming a mono-diameter wellbore casing in a borehole located in a subterranean formation including a preexisting wellbore casing, comprising:

means for installing a tubular liner and a first expansion cone in the borehole;

means for injecting a fluidic material into the borehole;

means for pressurizing a portion of an interior region of the tubular liner below the first expansion cone;

means for radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone; and

means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using a second expansion cone.

8. The apparatus of claim 7, wherein the means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for permitting fluidic materials displaced by the second expansion cone to be removed.

9. The apparatus of claim 8, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

10. The apparatus of claim 7, wherein the means for radially expanding at least a portion of the preexisting wellbore casing and the tubular liner using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for compressing at least a portion of the subterranean formation using fluid pressure.

11. The apparatus of claim 10, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

12. The apparatus of claim 7, further comprising:

means for injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

13. A method of joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member, comprising:

positioning a first expansion cone within an interior region of the second tubular member;

pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone;

extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member; and

radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

14. The method of claim 13, wherein radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

15. The method of claim 14, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

16. The method of claim 13, wherein radially expanding at least a portion of the first and second tubular members using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

17. The method of claim 16, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

18. The method of claim 13, further comprising:

injecting a hardenable fluidic sealing material into an annulus around the second tubular member.

19. An apparatus for joining a second tubular member to a first tubular member positioned within a subterranean formation, the first tubular member having an inner diameter greater than an outer diameter of the second tubular member, comprising:

means for positioning a first expansion cone within an interior region of the second tubular member;

means for pressurizing a portion of the interior region of the second tubular member adjacent to the first expansion cone;

means for extruding at least a portion of the second tubular member off of the first expansion cone into engagement with the first tubular member; and

means for radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

20. The apparatus of claim 19, wherein the means for radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for permitting fluidic materials displaced by the second expansion cone to be removed.

21. The apparatus of claim 20, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

22. The apparatus of claim 19, wherein the means for radially expanding at least a portion of the first tubular member and the second tubular member using the second expansion cone comprises:

means for displacing the second expansion cone in a longitudinal direction; and

means for compressing at least a portion of the subterranean formation using fluid pressure.

23. The apparatus of claim 22, wherein the means for displacing the second expansion cone in a longitudinal direction comprises:

means for applying fluid pressure to the second expansion cone.

24. The apparatus of claim 19, further comprising:

means for injecting a hardenable fluidic sealing material into an annulus around the second tubular member.

25. An apparatus, comprising:

a subterranean formation including a borehole;

a wellbore casing coupled to the borehole; and

a tubular liner coupled to the wellbore casing;

wherein the inside diameters of the wellbore casing and the tubular liner are substantially equal; and

wherein the tubular liner is coupled to the wellbore casing by a method comprising:

installing the tubular liner and a first expansion cone in the borehole;

injecting a fluidic material into the borehole;

pressurizing a portion of an interior region of the tubular liner below the first expansion cone;

radially expanding at least a portion of the tubular liner in the borehole by extruding at least a portion of the tubular liner off of the first expansion cone; and

radially expanding at least a portion of the wellbore casing and the tubular liner using a second expansion cone.

26. The apparatus of claim 25, wherein radially expanding at least a portion of the wellbore casing and the tubular liner using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

27. The apparatus of claim 26, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

28. The apparatus of claim 25, wherein radially expanding at least a portion of the wellbore casing and the tubular liner using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

29. The apparatus of claim 28, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

30. The apparatus of claim 25, wherein the annular layer of the fluidic sealing material is formed by a method comprising:

injecting a hardenable fluidic sealing material into an annulus between the tubular liner and the borehole.

31. An apparatus, comprising:

a subterranean formation including a borehole;

a first tubular member coupled to the borehole; and

a second tubular member coupled to the wellbore casing;

wherein the inside diameters of the first and second tubular members are substantially equal; and

wherein the second tubular member is coupled to the first tubular member by a method comprising:

installing the second tubular member and a first expansion cone in the borehole;

injecting a fluidic material into the borehole;

pressurizing a portion of an interior region of the second tubular member below the first expansion cone;

radially expanding at least a portion of the second tubular member in the borehole by extruding at least a portion of the second tubular member off of the first expansion cone; and

radially expanding at least a portion of the first tubular member and the second tubular member using a second expansion cone.

26. The apparatus of claim 25, wherein radially expanding at least a portion of the first and second tubular members using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

permitting fluidic materials displaced by the second expansion cone to be removed.

27. The apparatus of claim 26, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

28. The apparatus of claim 25, wherein radially expanding at least a portion of the first and second tubular members using the second expansion cone comprises:

displacing the second expansion cone in a longitudinal direction; and

compressing at least a portion of the subterranean formation using fluid pressure.

29. The apparatus of claim 28, wherein displacing the second expansion cone in a longitudinal direction comprises:

applying fluid pressure to the second expansion cone.

30. The apparatus of claim 25, wherein the annular layer of the fluidic sealing material is formed by a method comprising:

injecting a hardenable fluidic sealing material into an annulus between the first tubular member and the borehole.

31. An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

a tubular support including first and second passages;

a sealing member coupled to the tubular support;

a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage; and

an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

32. A method of radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

positioning an expansion cone within the wellbore casing above the overlapping joint;

sealing off an annular region within the wellbore casing above the expansion cone;

displacing the expansion cone by pressurizing the annular region; and

removing fluidic materials displaced by the expansion cone from the tubular liner.

33. The method of claim 32, further comprising:

supporting the expansion cone during the displacement of the expansion cone.

34. An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

means for positioning an expansion cone within the wellbore casing above the overlapping joint;

means for sealing off an annular region within the wellbore casing above the expansion cone;

means for displacing the expansion cone by pressurizing the annular region; and

means for removing fluidic materials displaced by the expansion cone from the tubular liner.

35. The apparatus of claim 34, further comprising:

means for supporting the expansion cone during the displacement of the expansion cone.

36. An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

a tubular support including a first passage;

a sealing member coupled to the tubular support;

a releasable latching member coupled to the tubular support; and

an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

37. A method of radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

positioning an expansion cone within the wellbore casing above the overlapping joint;

sealing off a region within the wellbore casing above the expansion cone;

releasing the expansion cone; and

displacing the expansion cone by pressurizing the annular region.

38. The method of claim 37, further comprising:

pressurizing the interior of the tubular liner.

39. An apparatus for radially expanding an overlapping joint between a wellbore casing and a tubular liner, comprising:

means for positioning an expansion cone within the wellbore casing above the overlapping joint;

means for sealing off a region within the wellbore casing above the expansion cone;

means for releasing the expansion cone; and

means for displacing the expansion cone by pressurizing the annular region.

40. The apparatus of claim 39, further comprising:

means for pressurizing the interior of the tubular liner.

41. An apparatus for radially expanding an overlapping joint between first and second tubular members, comprising:

a tubular support including first and second passages;

a sealing member coupled to the tubular support;

a slip joint coupled to the tubular support including a third passage fluidicly coupled to the second passage; and

an expansion cone coupled to the slip joint including a fourth passage fluidicly coupled to the third passage.

42. A method of radially expanding an overlapping joint between first and second tubular members, comprising:

positioning an expansion cone within the first tubular member above the overlapping joint;

sealing off an annular region within the first tubular member above the expansion cone;

displacing the expansion cone by pressurizing the annular region; and

removing fluidic materials displaced by the expansion cone from the second tubular member.

43. The method of claim 42, further comprising:

supporting the expansion cone during the displacement of the expansion cone.

44. An apparatus for radially expanding an overlapping joint between first and second tubular members, comprising:

means for positioning an expansion cone within the first tubular member above the overlapping joint;

means for sealing off an annular region within the first tubular member above the expansion cone;

means for displacing the expansion cone by pressurizing the annular region; and

means for removing fluidic materials displaced by the expansion cone from the second tubular member.

45. The apparatus of claim 44, further comprising:

means for supporting the expansion cone during the displacement of the expansion cone.

46. An apparatus for radially expanding an overlapping joint between first and second tubular members, comprising:

a tubular support including a first passage;

a sealing member coupled to the tubular support;

a releasable latching member coupled to the tubular support; and

an expansion cone releasably coupled to the releasable latching member including a second passage fluidicly coupled to the first passage.

47. A method of radially expanding an overlapping joint between first and second tubular members, comprising:

positioning an expansion cone within the first tubular member above the overlapping joint;

sealing off a region within the first tubular member above the expansion cone;

releasing the expansion cone; and

displacing the expansion cone by pressurizing the annular region.

48. The method of claim 47, further comprising:

pressurizing the interior of the second tubular member.

49. An apparatus for radially expanding an overlapping joint between first and second tubular members, comprising:

means for positioning an expansion cone within the first tubular member above the overlapping joint;

means for sealing off a region within the first tubular member above the expansion cone;

means for releasing the expansion cone; and

means for displacing the expansion cone by pressurizing the annular region.

50. The apparatus of claim 49, further comprising:

means for pressurizing the interior of the second tubular member.

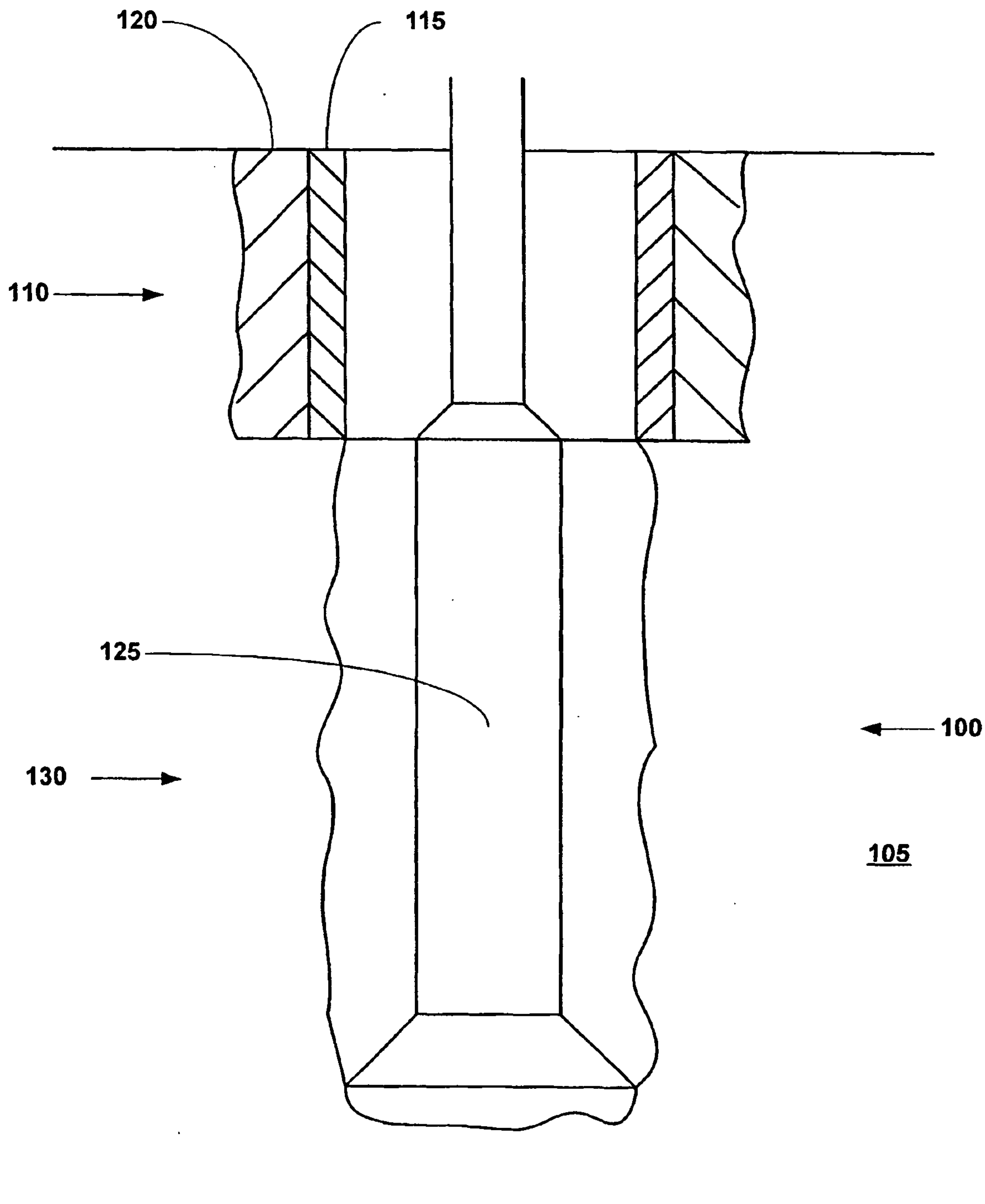

FIGURE 1

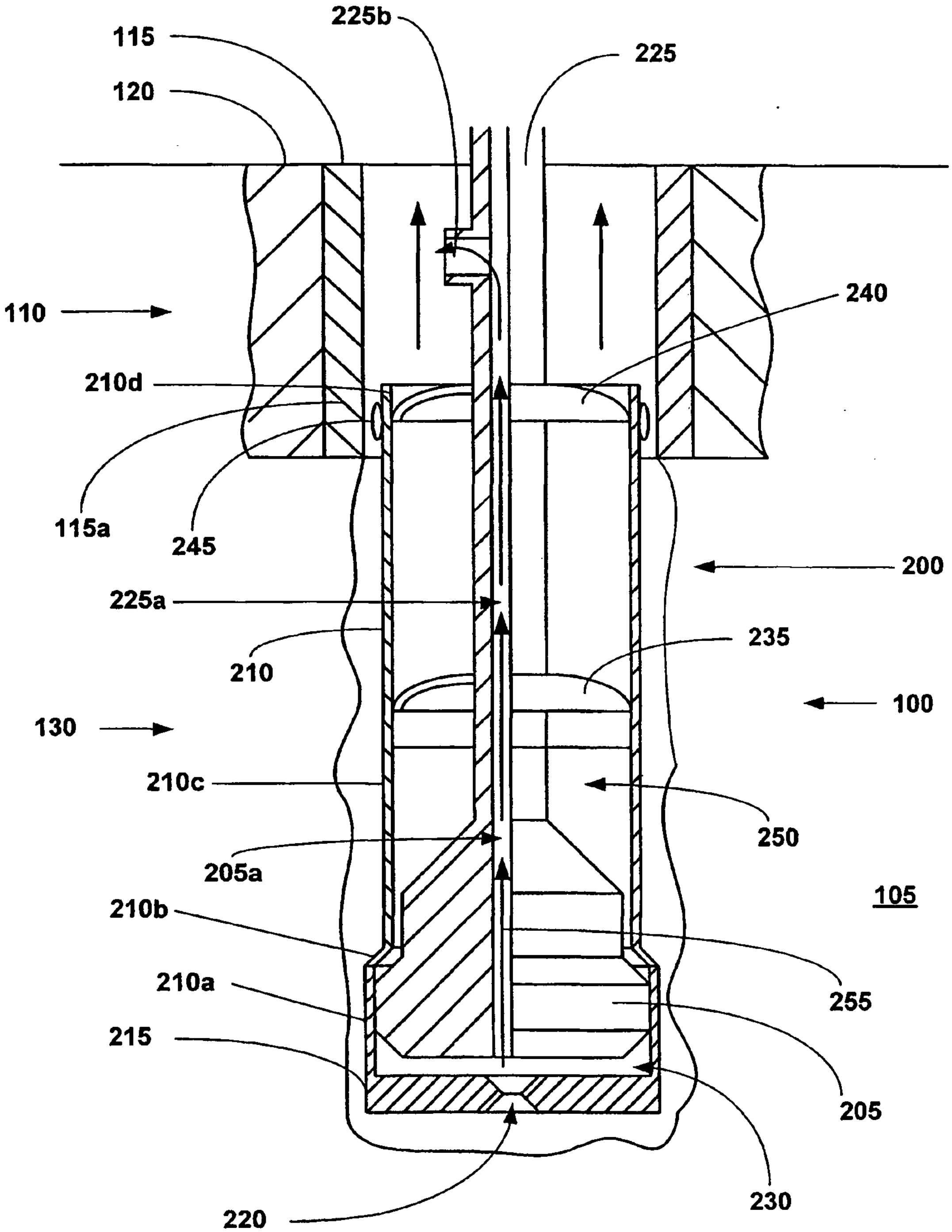
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FIGURE 2

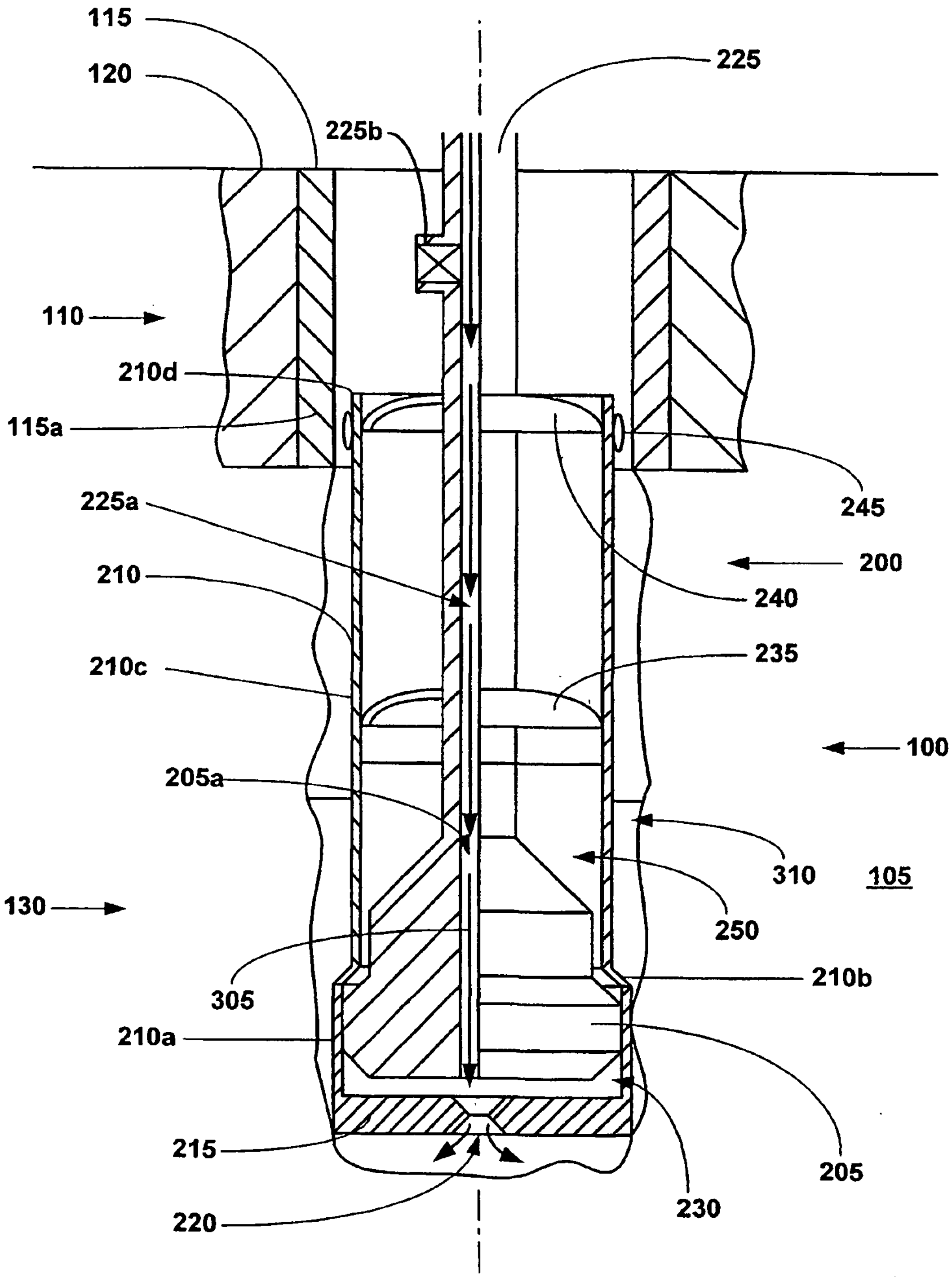
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FIGURE 3

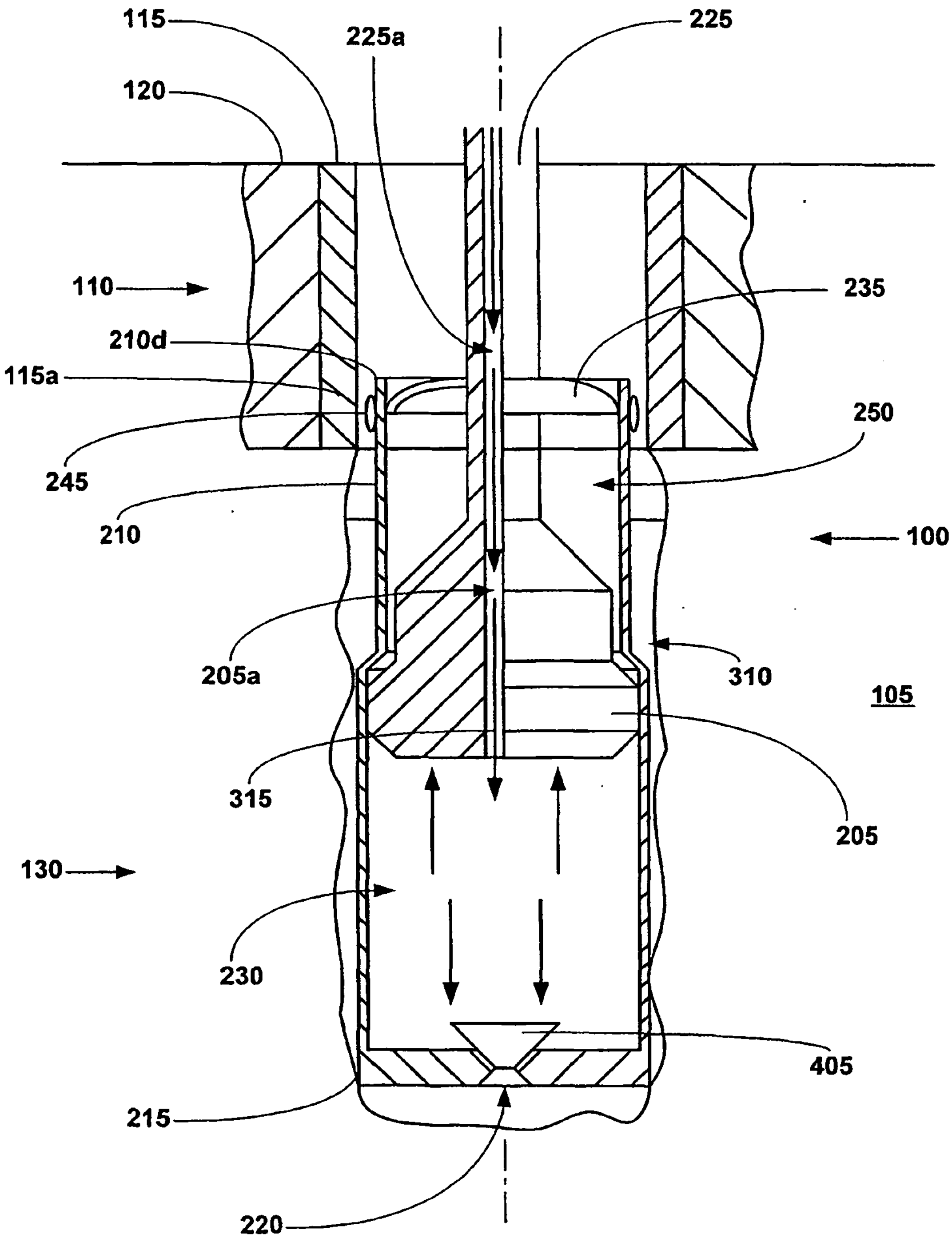
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FIGURE 4

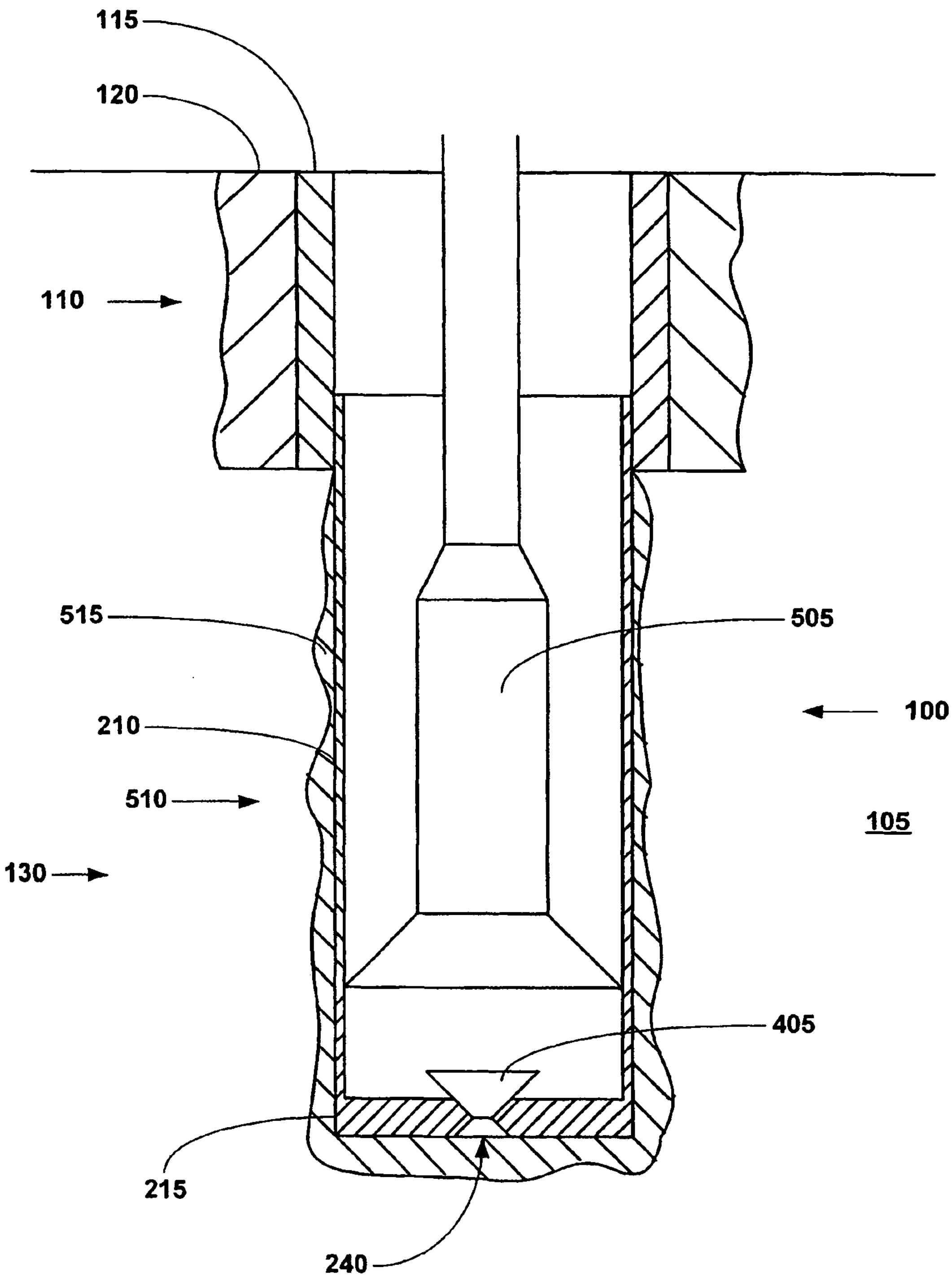
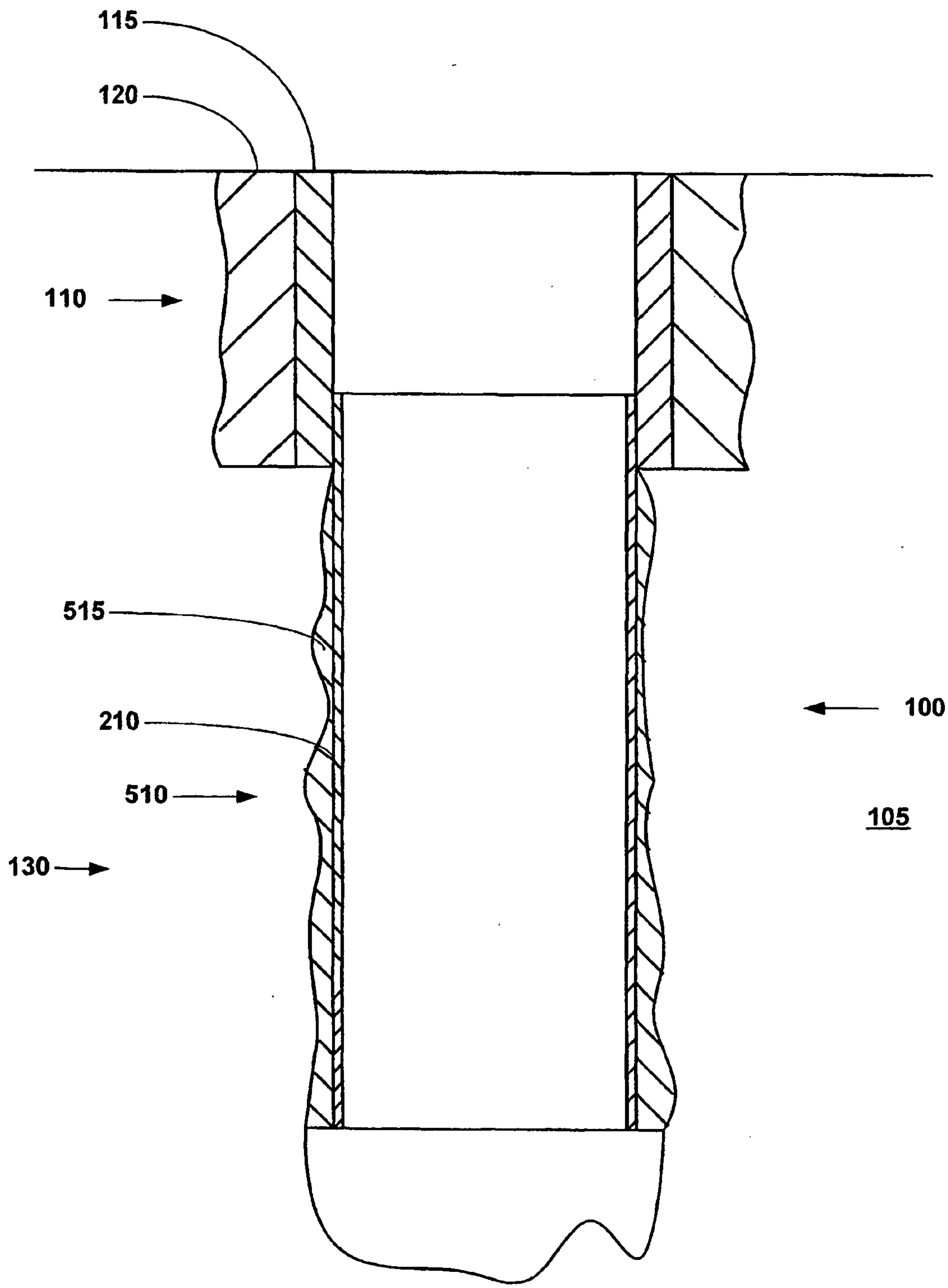


FIGURE 5



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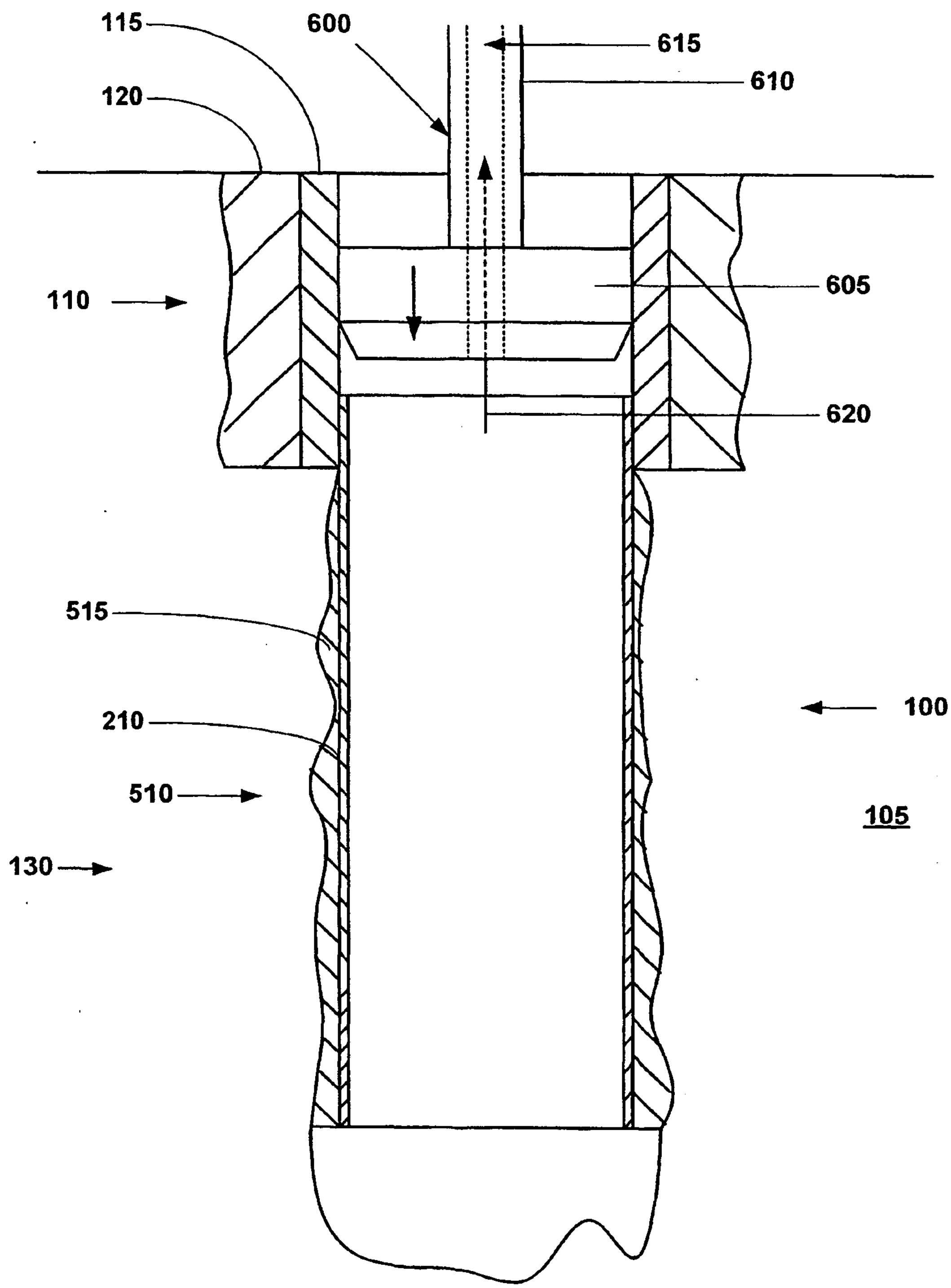

FIGURE 7

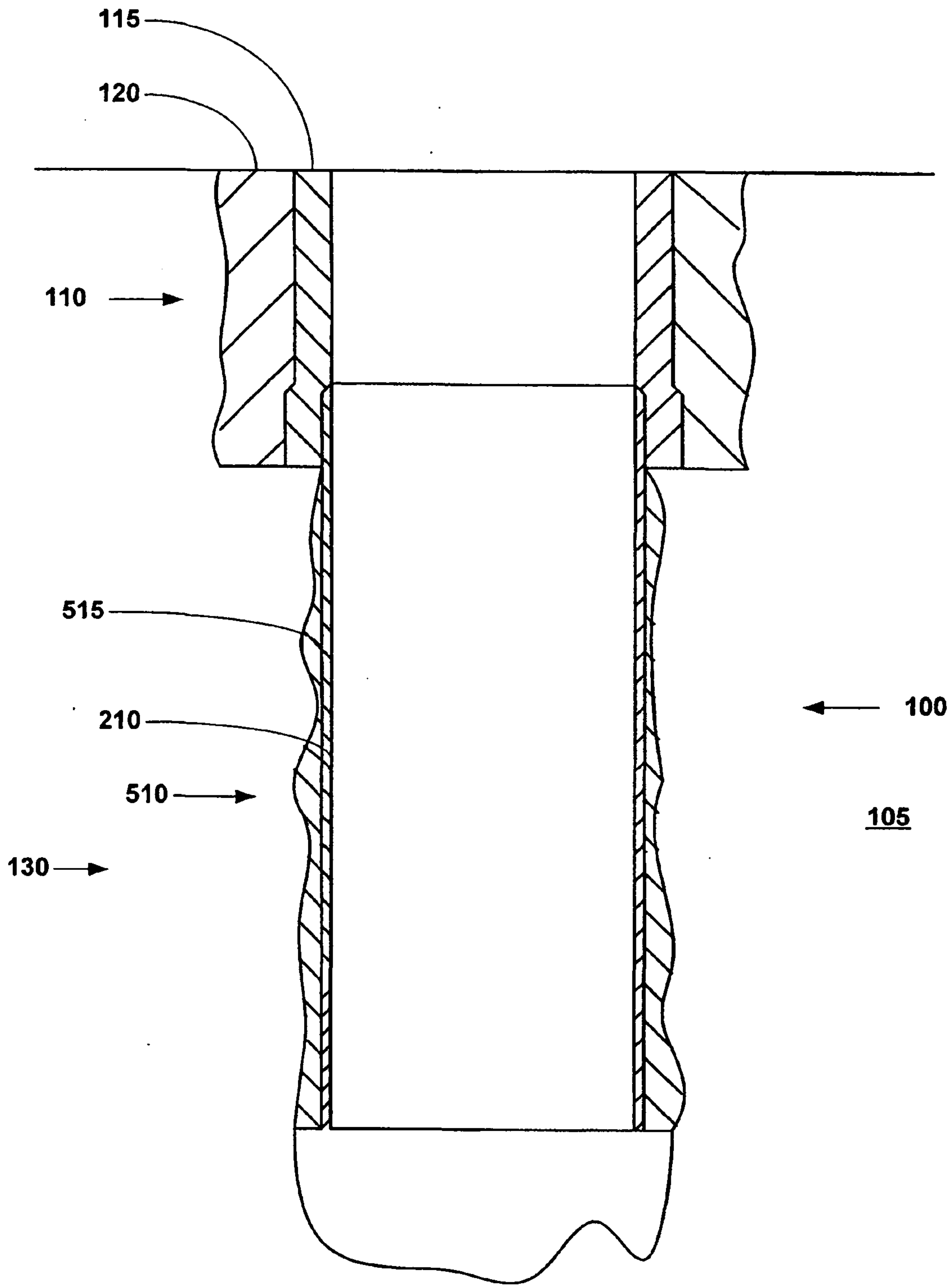

FIGURE 8

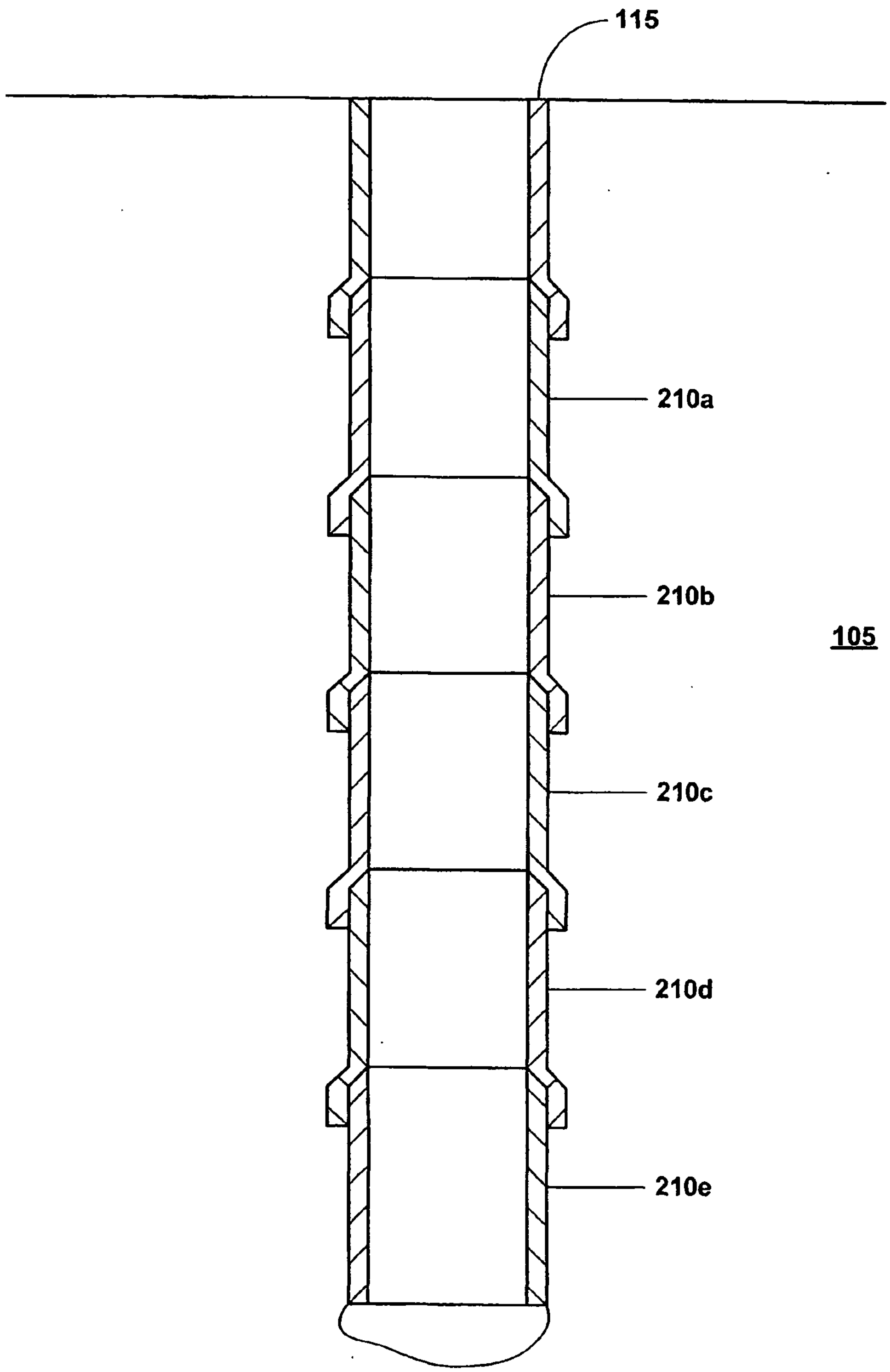

FIGURE 9

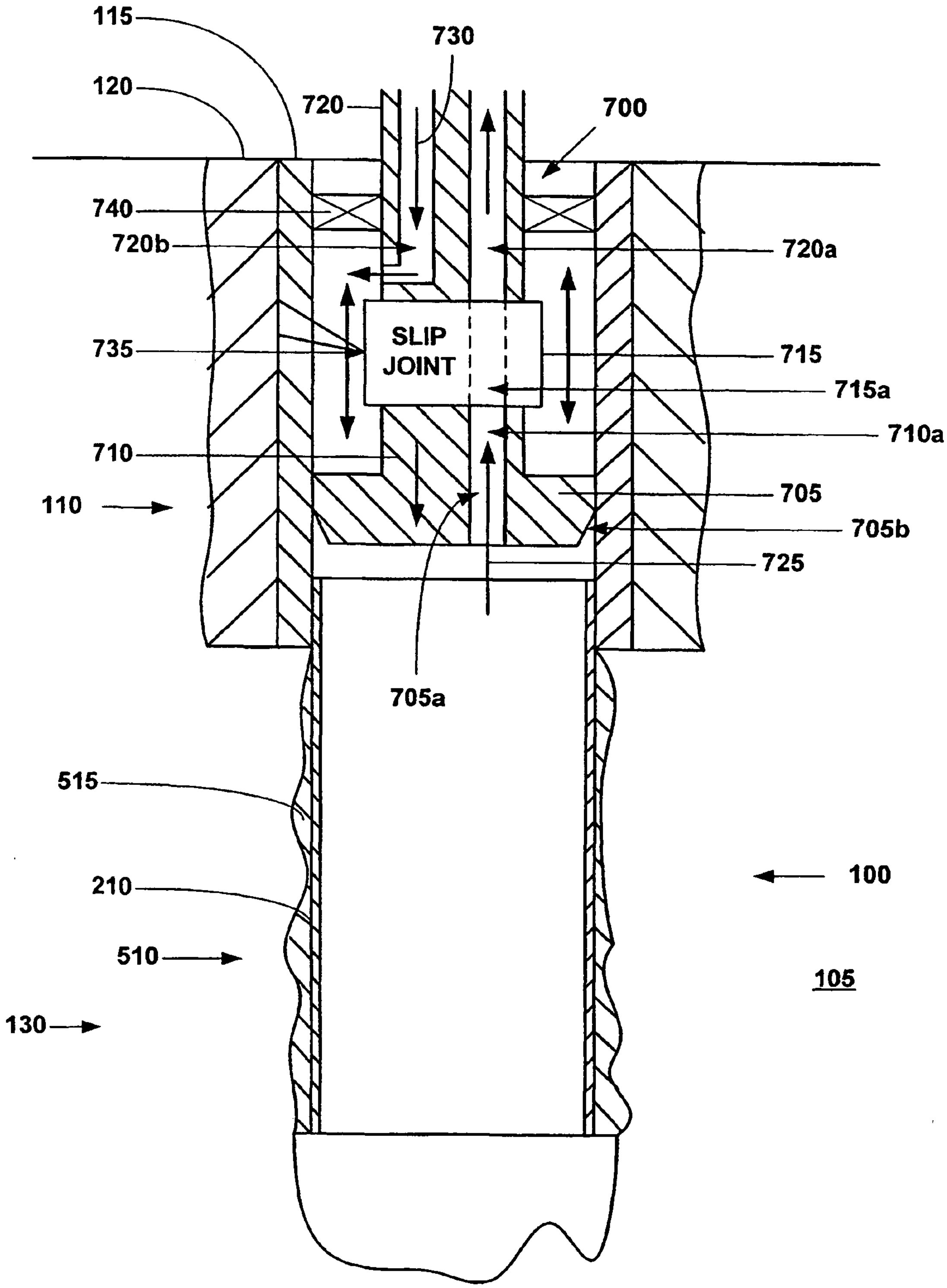
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FIGURE 10

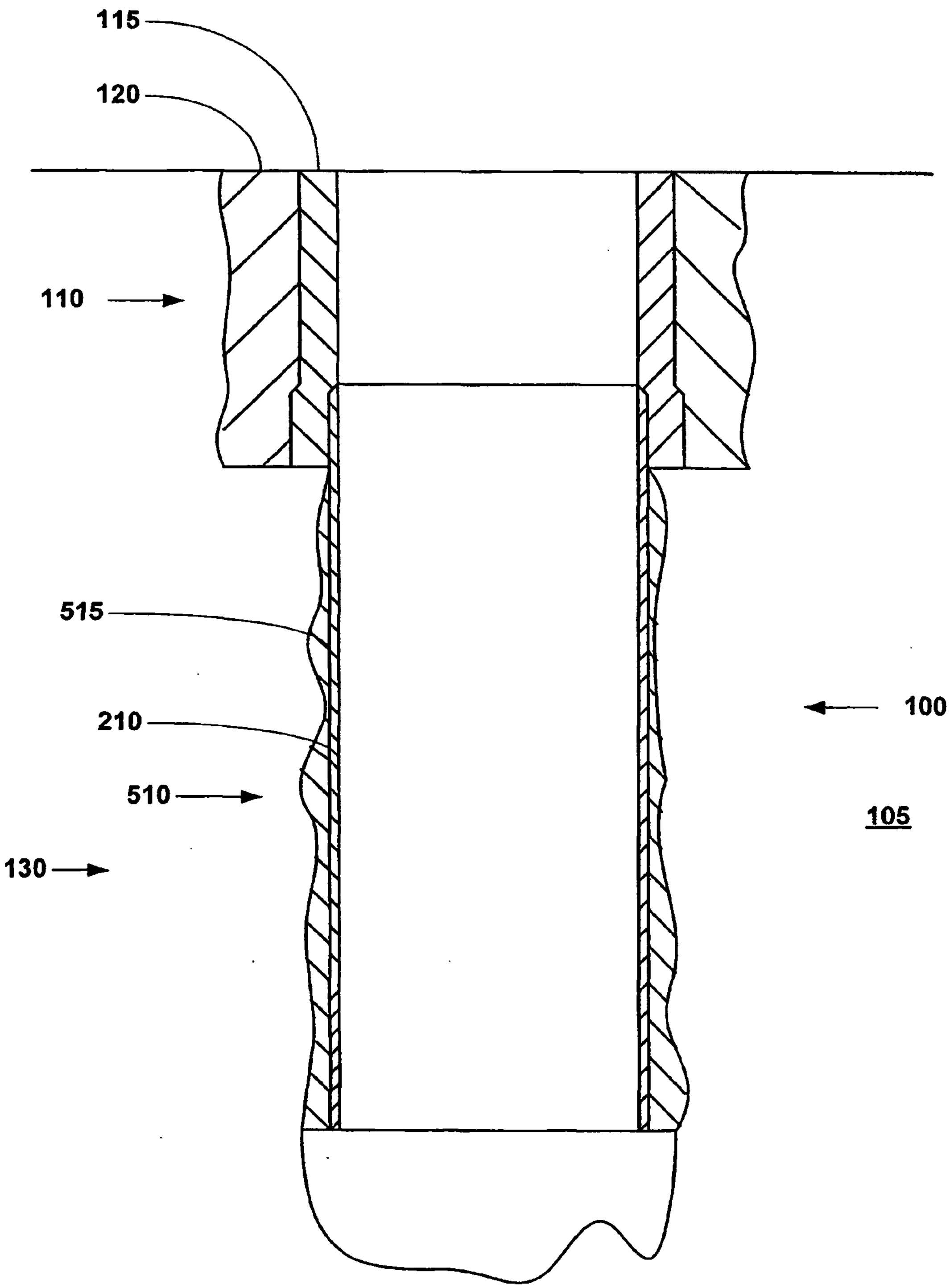

FIGURE 11

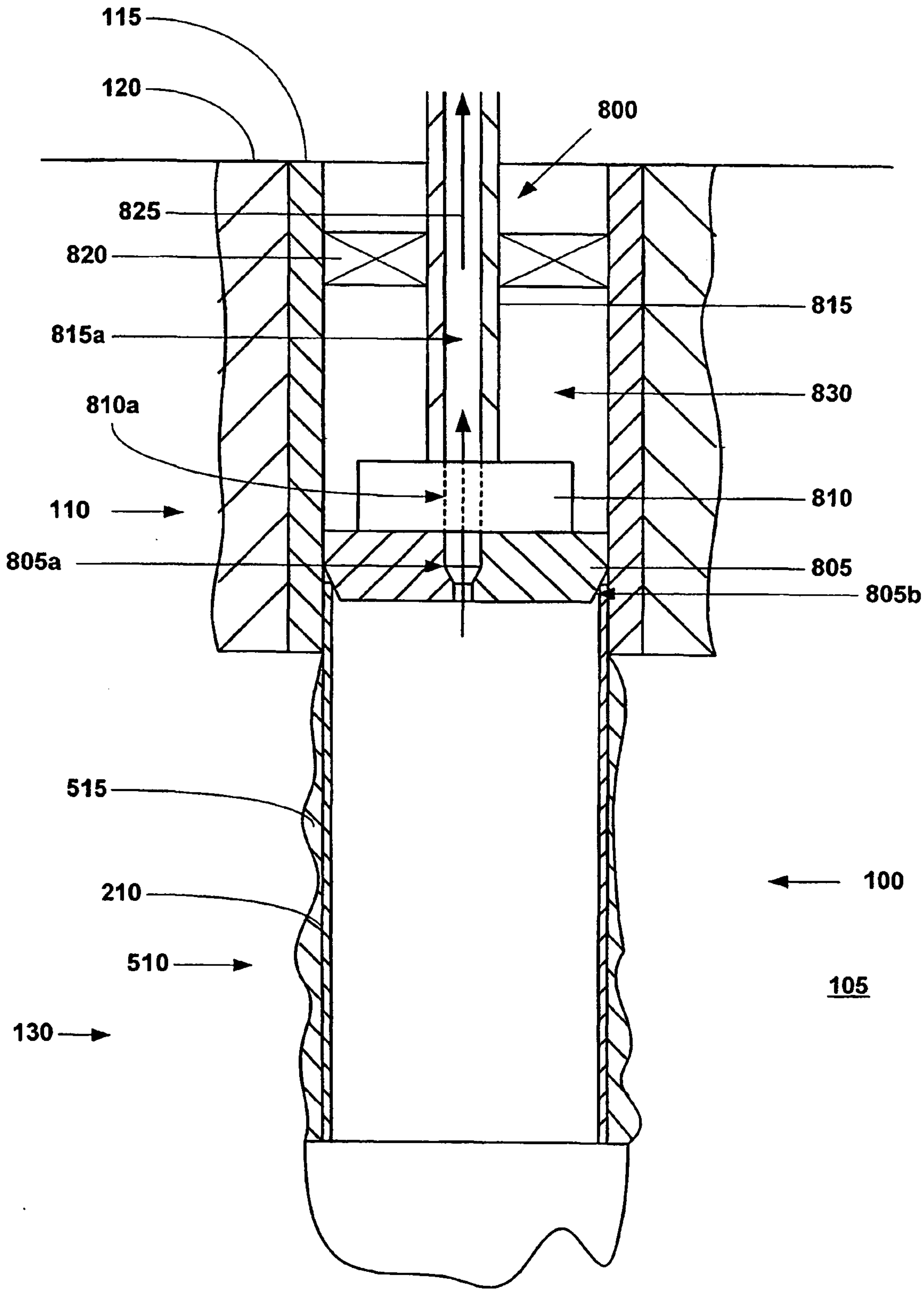
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FIGURE 12

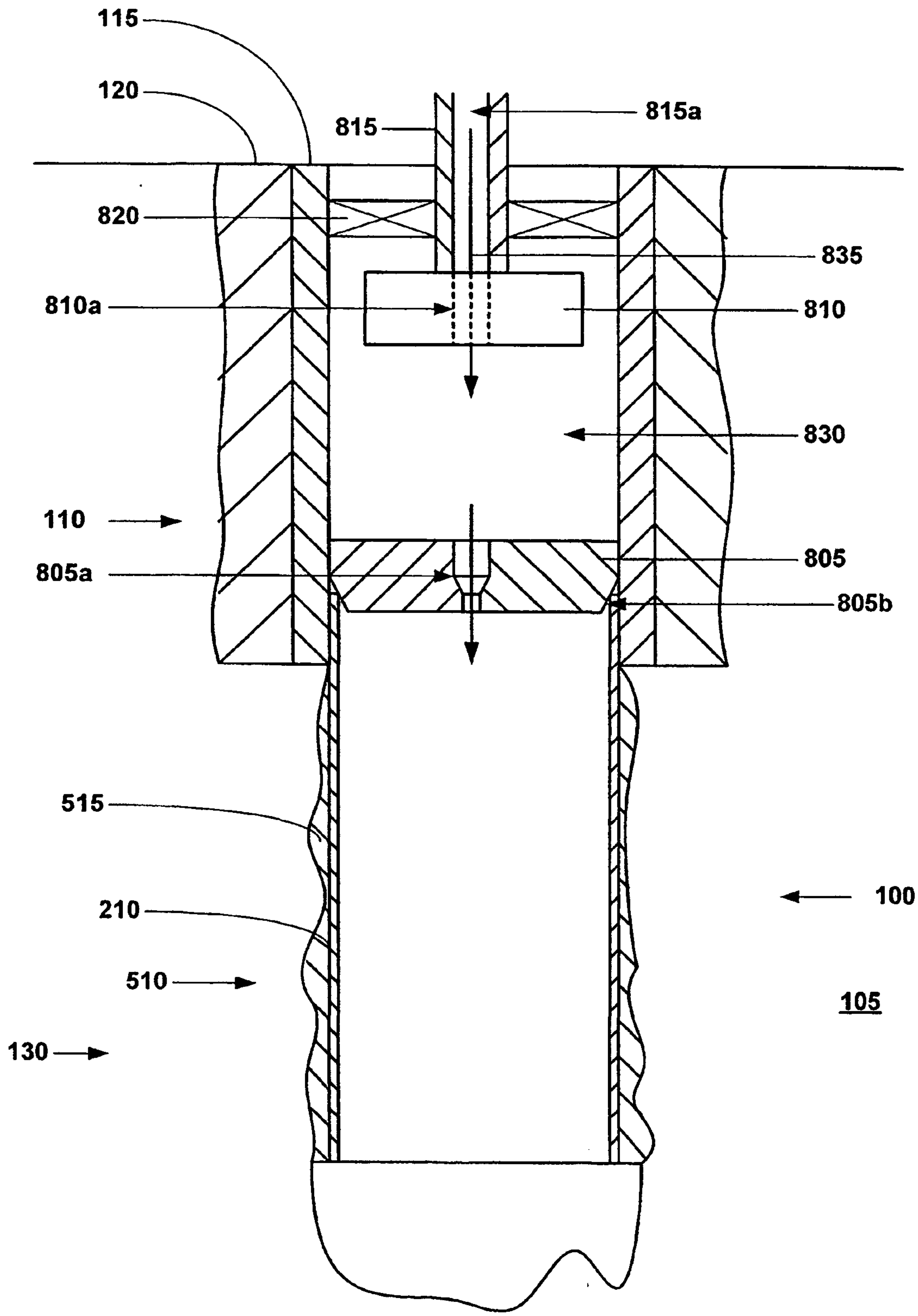
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FIGURE 13

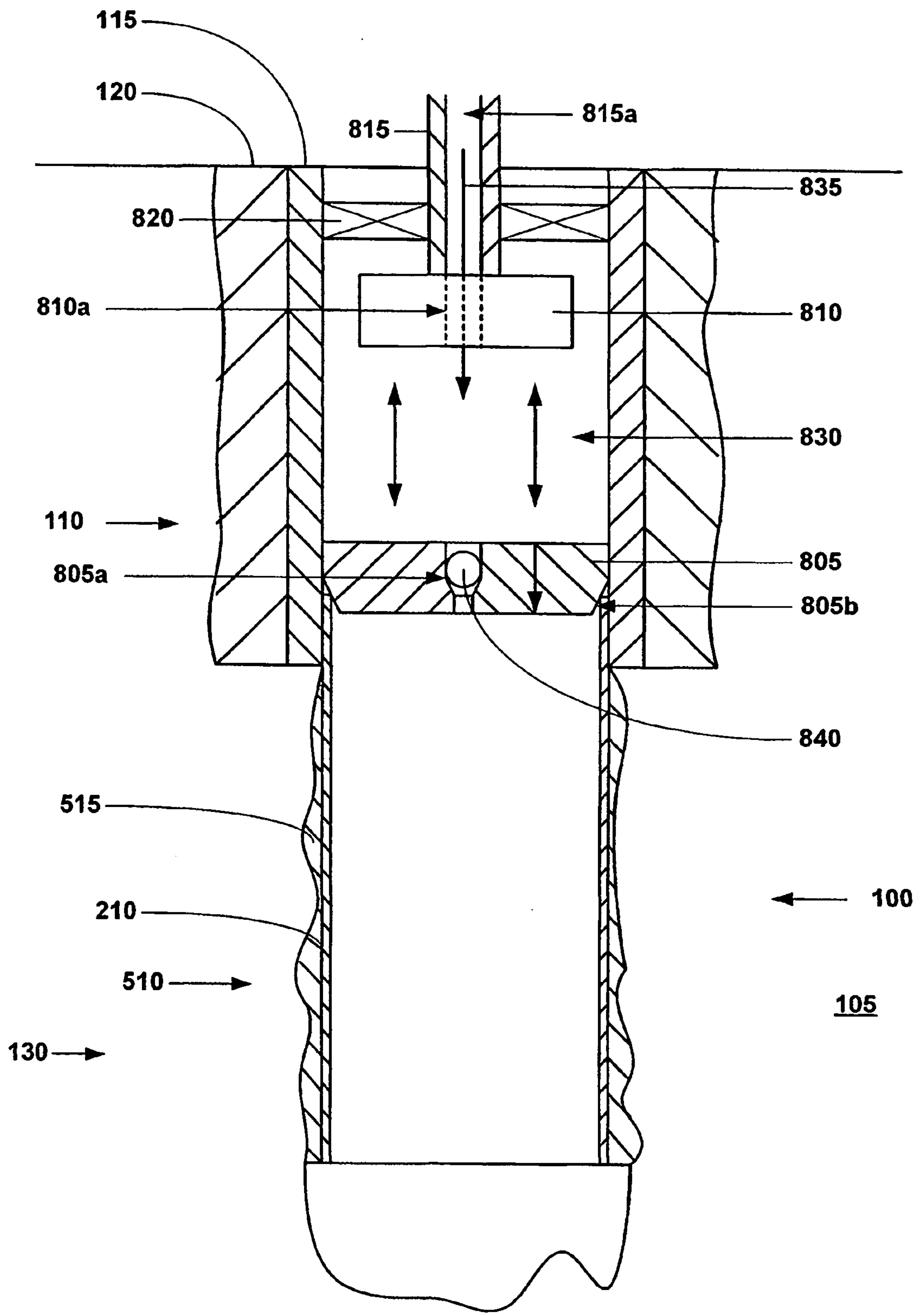
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FIGURE 14

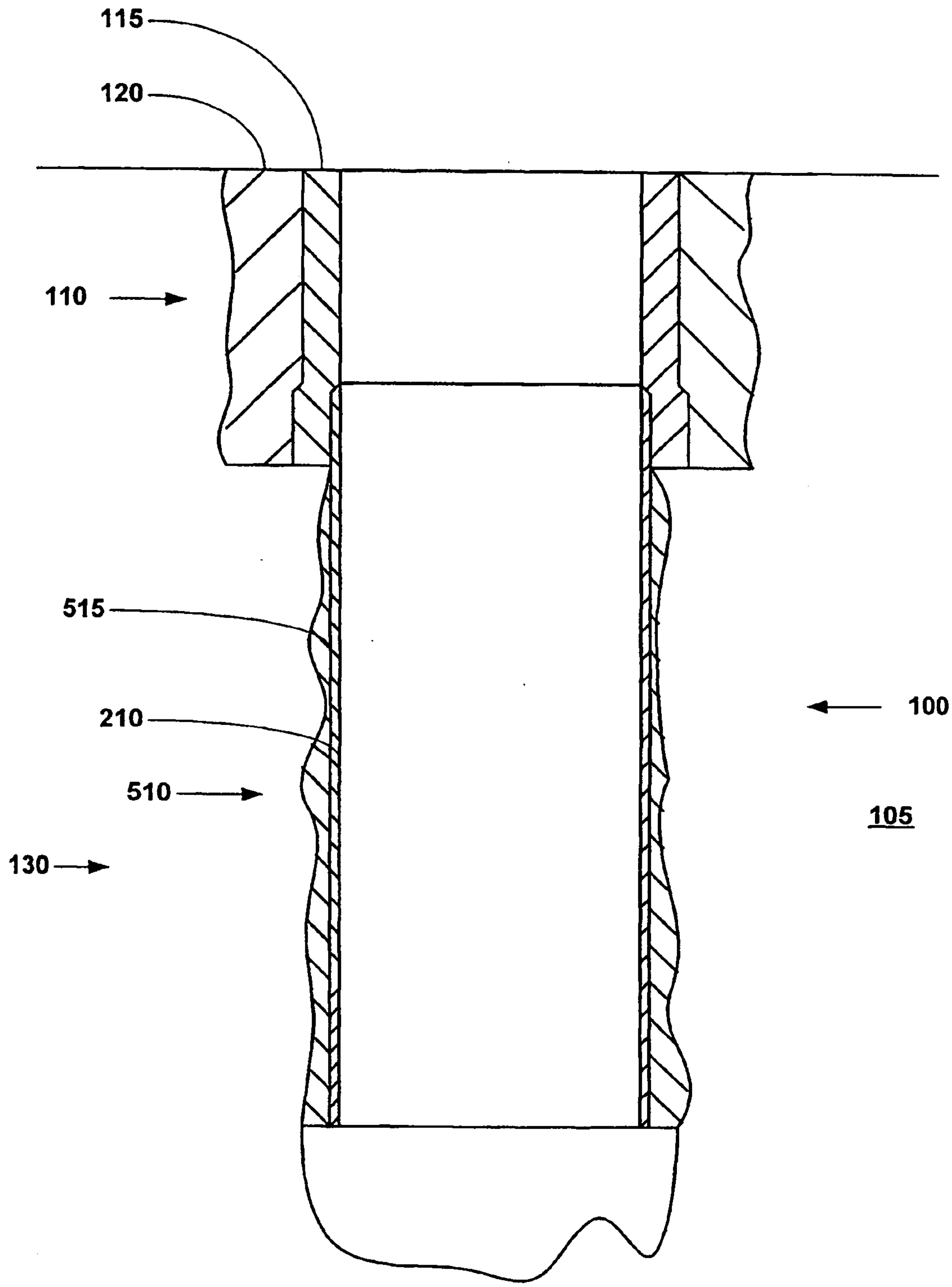

FIGURE 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/00677

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 19/16, 23/00
US CL : 166/380, 207

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 166/380, 207, 85.1, 177.4, 212, 216, 217, 242.1, 378

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,085,838 A (VERCAEMER et al.) 11 July 2000 (11.07.00), abstract; figures 2 and 5-7; claims 1-12.	1-50

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 22 May 2002 (22.05.2002)	Date of mailing of the international search report 17 JUL 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer H. Leon Mendoza David Bagnell Telephone No. (703) 308-1113

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(72) Inventors; and

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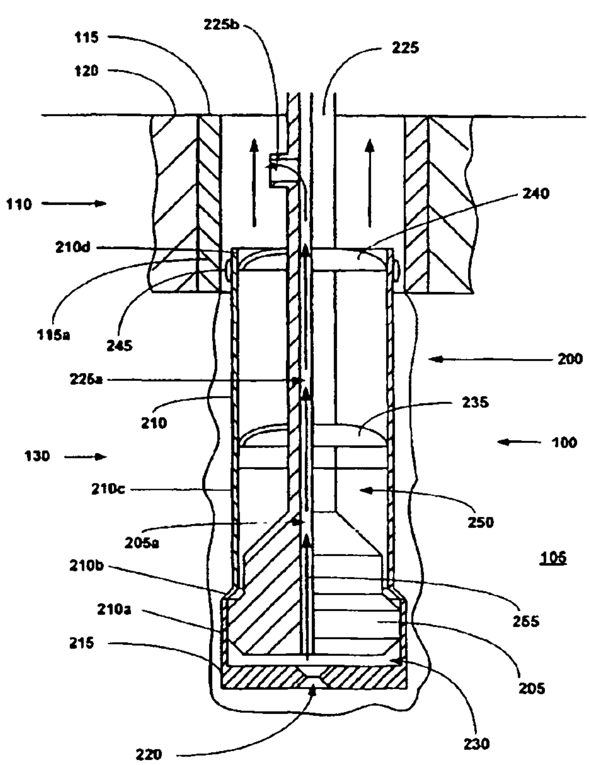
(74) Agents: MATTINGLY, Todd et al.; Haynes & Boone, LLP, Suite 4300, 1000 Louisiana Street, Houston, TX 77002-5012 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,

[Continued on next page]

(54) Title: MONO-DIAMETER WELLBORE CASING



(57) Abstract: A mono-diameter casing formed when a tubular liner (210) and an expansion cone (205) are positioned within a new section fo a wellbore (100) and the tubular liner (210) is overlapped with a pre-existing casing (115). A hardening fluid is injected into the section of the wellbore (100) below the level of the expansion cone (205) and into the annular region between the tubular liner (210) and the wellbore (100). The inner and outer regions of the tubular liner (210) are isolated. Then a non-hardening fluid is injected into the interior region of the tubular liner (210) to pressurize it below the expansion cone (205). The overlapping portion of the pre-existing casing (115) and the tubular liner (210) are then expanded using an expansion cone (205).

WO 02/068792 A1

GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*
— *with amended claims*

Date of publication of the amended claims: 31 October 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS

[received by the International Bureau on 23 August 2002 (23.08.02);
new claims 51-55 added; remaining claims unchanged (1 page)]

51. The method of claim 1, wherein the inside diameter of the portion of the tubular liner radially expanded by the first expansion cone is equal to the inside diameter of the portion of the preexisting wellbore casing that was not radially expanded by the second expansion cone.

52. The apparatus of claim 7, wherein the inside diameter of the portion of the tubular liner radially expanded by the first expansion cone is equal to the inside diameter of the portion of the preexisting wellbore casing that was not radially expanded by the second expansion cone.

53. The method of claim 13, wherein the inside diameter of the portion of the tubular liner extruded off of the first expansion cone is equal to the inside diameter of the portion of the preexisting wellbore casing that was not radially expanded by the second expansion cone.

54. The apparatus of claim 19, wherein the inside diameter of the portion of the tubular liner extruded off of the first expansion cone is equal to the inside diameter of the portion of the preexisting wellbore casing that was not radially expanded by the second expansion cone.

55. The apparatus of claim 25, wherein the inside diameter of the portion of the tubular liner radially expanded by the first expansion cone is equal to the inside diameter of the portion of the preexisting wellbore casing that was not radially expanded by the second expansion cone.